USSR Report

ELECTRONICS AND ELECTRICAL ENGINEERING

No. 90

USSR REPORT

Electronics and Electrical Engineering

No. 90

Contents

BROADCASTING, CONSUMER ELECTRONICS

CIRCUITS & SYSTEMS

COMMUNICATIONS

COMPONENTS, HYBRIDS & MANUFACTURING TECHNOLOGY

PARTIAL VOLUME OF BODIES OF INDETERMINATE FORM OF PHASE MANIPULATED SIGNALS
IN DOPPLER BAND

GUTIN, V. S.

[Abstract] During analysis and synthesis of systems of active radar and sonar detection, radio communication via channels with ionosphere and troposphere scattering, underwater acoustic communication, and in a number of other cases, an integral model of interference of the type of interference reflections (reverberation) is used, which is characterized by the density of scattering of the signal $\gamma^2(t,F)$ with respect to the delay t and the Doppler frequency shift F. In many practicable situations it is possible to consider that the density γ^2 is different from zero only in some region D_γ of a plane (t,F) and is constant in this region. With such assumptions the interference power at the output of a filter matched with the signal is proportional to the partial volume of the body of indeterminate form (TN) of a signal in the interference zone D_γ. The interference zone D_γ can have an arbitrary configuration. The most typical, however, is when the interference reflections are concentrated in the Doppler band $D_\gamma = (-T,T; -F_p,F_p)$ where T is the duration of the signal; $2F_p$ is the width of the Doppler band, which is determined by the maximum possible radial speed of the scatterers. If the Doppler frequency of the signal received equals F_0, then the interference power is determined by the partial volume TN V in the shifted band $D_\gamma = (-TT; F_0-F_p, F_0 + F_p)$:

$$V = \int_{F_o-F_p}^{F_o + F_p} \int_{-T}^{T} |R(t,F)|^2 \, dtdF, \tag{1}$$

where $R(t,F)$ is the ambiguity function (FN) of the radiated signal. The interior integral in (1) is the area of the cross section of TN, with the plane $F = $ constant

1

$$P(F) = \int_{-T}^{T} |R(t, F)|^2 \, dt$$

The present work derives formulas for calculation of the areas P(F) of binary phase manipulated (PM) signals which are widely used in location and communication. The form of the Doppler cross section of FN is analyzed. The dependences of the partial volume TN V on the shifts of F_o are presented for several concrete PM signals and with averaging in the case of binary sequences. Sections of the work are devoted to an examination of the following: 1) Doppler cross sections of the ambiguity functions of PM signals; 2) Area of Doppler cross section of TN; and 3) Partial volume of body of indeterminate form in Doppler band. It is concluded that the formulas presented in the work make it possible to calculate the form of the Doppler cross sections of FN, the area of the cross sections TN and the partial volume of TN in the Doppler band for binary PM signals. From figures 3 and 4 in the work it is seen that the partial volume TN decreases with an increase of the Doppler shift F_o extremely slowly and preserves a significant magnitude in the case of large Doppler shifts, which is explained by the strong curvature of the FN module at the elementary sections θ_k, with large F_{τ_o}. The results of a statistical experiment show that the volume TN of the PM signals in the frequency band $2F_p = 2\tau_o$ amounts to approximately 8 and slightly depends on the form of the signal ($\sigma_u / <V> \approx 0.02$). The variance of the magnitude of the volume TN in the Doppler band increases with a decrease of the bandwidth; with a bandwidth $2F_p = 0.1 \tau_o$ the magnitude V is still very stable. Figures 4; references 9: 6 Russian, 3 Western in translation.
[89-6415]

UDC 621.391:621.636

DIGITAL PROCESSING OF SIGNAL OF INTERNATIONAL SYSTEM OF AIRCRAFT LANDINGS ON BACKGROUND OF RE-REFLECTION

BERNYUKOV, A. K.

[Abstract] The paper is concerned with problems of an increase of the noise immunity of an international system of aircraft landings with a scanning beam and readout of time (MSP SLOV) with the presence of re-reflections and in a condition of minimum a priori information. Algorithms of digital processing in real time are proposed which make it possible to separate the signal and re-reflections in a multibeam signal and to measure the information parameter. The results obtained confirm the reasons expressed in the work concerning localization of the logarithmic spectrum (kepstr) in the form of a pulse sequence on the background of the kepstr of a basic signal. The effect of noisy interference N_Σ (t), the model of which for MSP SLOV is considered in a 1981 paper

by the author of the present work, reduces to worsening of the operation of a kepstr analyzer and an inversion filter. However, the use of adaptive compensation of noisy interference, the level of which is not great, makes it possible to rely on the effectiveness of the method considered for increasing the noise immunity of MsP SLOV. Figures 4; references: 7 Russian.
[89-6415]

EVALUATION OF EFFECTIVENESS OF RADIOELECTRONICS PILOT-NAVIGATION COMPLEXES

YARLYKOV, M. S. and BOGACHEV, A. S.

[Abstract] The principal features are presented of a proposed method based on the theory of Markov processes, for evaluating the effectiveness of functioning of a radioelectronic pilot-navigation complex (PNC). The novelty of the methods of evaluation described involves: use of model of elements with three states which makes it possible to take into consideration the temporary failure of radio engineering devices and systems and thus more precisely to calculate the probability of the fitness for work of the complex states; and the use of a conditional criterion of effectiveness, sufficiently completely characterizing the quality of solution of PNC navigation problems. The following items are examined: 1) Principal calculation formula; 2) Choice and justification of conditional criterion of effectiveness of functioning PNC; and 3) Determination of probabilities of fitness for work of PNC states. The proposed method can find use during evaluation of the effectiveness, not only of PNC, but also more elaborate multifunctional airborne complexes. Figures 2, references: 4 Russian.
[89-6415]

DOPPLER SHIFT OF RADIO SIGNAL FREQUENCY IN IONOSPHERE WAVEGUIDE CHANNEL

STAKHANOV, I. P., Moscow Evening Metallurgical Institute

[Abstract] The object of this paper is to show that by the nature of the
spectrum of a Doppler shift of frequency, which originates in an ionosphere
waveguide channel, it is possible to judge concerning the distribution of a
world-wide signal with respect to modes which differ by various values of the
adiabatic invariant. It is assumed for simplicity that the index of refraction
μ depends on only one vertical coordinate (z), i.e., that at the section of the
channel under consideration it is possible to disregard the dependence of μ on
the horizontal coordinate (x) and to consider certain averagings with respect
to x of the value of the channel parameters. At first, a plane waveguide is
considered which simplifies the interpretation of the results obtained. Later
the limitation is easily removed which is done at the end of the work.
References 4: 3 Russian, 1 Western in translation.
[115-6415]

SPACE-TIME DEPENDENCES OF PARAMETERS OF DECIMETER RADIO WAVE PROPAGATION AT
HIGH LATITUDES

BLAGOVESHCHENSKIY, D. V., Leningrad Polytechnical Institute

[Abstract] The results are presented of an investigation of the space-time
correlation of the parameters MNCh (maximum observable frequency), MPCh
(maximum applicable frequency) and NNCh (minimum observable frequency) from
data of inclined sounding of the ionosphere at a varying frequency (range of

frequency, 3.5 ÷ 27.5 MHz) at three high-latitude radio paths. Experimental investigations were conducted 24 hours a day in winter periods and at the equinox (from September 1977 to April 1978) simultaneously on all the three radio paths mentioned above. It is concluded that the radiuses of the space and time correlation of the basic parameters prevailing at the high-latitude radio paths are substantially smaller than at the middle latitudes. The maximum values of the correlation radiuses are attained in daytime hours. With an increase of magnetic activity, which is accompanied as a rule in daytime hours by negative ionosphere disturbances, the space and time correlation of MNCh and MPCh appear more noticeable. In nighttime hours with the entry of the regions of reflection of radio paths in the zone of an auroral ionization, the characteristics considered are practically not correlated, even at a distance on the order of 250 km. Thereby, the time and space extrapolation parameters of propagation are basically possible in daytime conditions at a distance not exceeding ~1000 km (in this case with respect to latitude) during not more than 1 hour. The possibilities of short-time forecasting of radio wave propagation, are, accordingly determined by such an evaluation. The author thanks A. V. Shirochkov and V. B. Smirnov for submitting the possibility of profiting by the materials of inclined sounding at radio path No 2. Figures 3; tables 3; references: 7 Russian.
[116-6415]

EQUATIONS OF LASER LOCATION IN SMALL ANGLE APPROXIMATION

KORSHUNOV, V. A., Institute of Experimental Meteorology

[Abstract] In the present work, in a small angle approximation, the problem is solved of the calculation of backward scattering for the general case of optical nonuniformity along the path of sounding the medium, taking account of the behavior of the scattering indicatrix near the directions forward and backward. Using sounding of a homogeneous semi-infinite medium as an example, some characteristics of forming back scattering are considered. Numerical calculations are presented, the results of which are compared with data obtained in an approximation of double scattering and by the Monte Carlo method. In order to illustrate a concrete applications of the relations derived in the present work and the comparisons obtained on their basis of the results with the data of other methods, a series of numerical calculations for the C-1 model of a cloud are made. It is concluded that procedures based on a small angle approximation are applicable for a quantitative estimate of back scattering signals. Figures 4; references 17: 16 Russian, 1 Western.
[116-6415]

EXPERIMENTAL INVESTIGATION OF PROPAGATION OF TWO-MILLIMETER RANGE RADIO WAVES
ABOVE THE SEA

BALAN, M. G., BESPECHNYY, S. B., GORBACH, N. V., LOBKOVA, L. M.,
MIKHAYLYUK, Yu. P., MISHAREVA, N. I., PEDENKO, Yu. A., RAZKAZOVSKIY, V. B.
and STEL'MAKH, V. V., Sevastopol' Instrument Building Institute

[Abstract] The results are presented of experimental investigations of the
fluctuations of the amplitude of 2-mm radio waves on a sea path. Some of the
problems touched upon in the present work are an extension of investigations
started in 1978 on a short sea path (L = 750 m) close to Sevastopol'. The
experiments considered here were fulfilled with the receiving point located at
a height of 5.5 m above the sea level. The antenna, together with the trans-
mitter, were located 25 m above the sea level at a distance of 9.6 km from the
receiver. The experiments were conducted during 6 days in the period from
October 1979 to February 1980 with low wind speeds (on the average approximately
3 m/s) and a slight sea (according to visual estimates the height of sea waves
amounted to 0.3 m), both with clear weather and in conditions of fog and
drizzling rain. The investigations were made with elliptical, close to circular,
polarization of radiation and with linear (both vertical and horizontal)
polarization of reception. It was possible to change the angle of inclination
of the electrical axis of the receiving antenna with reference to the direction
at the transmitter within the limits of several milliradians, which made it
possible to observe a change of the characteristic of the signal received in
proportion to the weakening of the direct beam. The results obtained are
compared with data for a short sea path. A comparison of the energy spectra
of the fluctuations of the signal amplitudes, propagating at short and long
paths with similar meteorological conditions makes it possible to conclude:
with an increase of the path length, the intensity of fluctuations in the low-
frequency region increases, as a result of which the width of the spectrum of
amplitude fluctuations of the signals is diminished. Figures 2; tables 3;
references 8: 6 Russian, 2 Western.
[116-6415]

ATTENUATION OF RADIO WAVE FIELD BY FERROCONCRETE BARRIER WITH RECTANGULAR
APERTURE

KOROLENKOV, A. V.

[Abstract] During planning for screened spaces, investigation of the biological
effects of radio waves and other problems connected with the propagation of
radio waves under urban conditions, it is necessary to consider the effect of
various elements of structures on the attenuation of radio waves, in particular
their walls. Because the walls of structures are primarily noncontinuous and
contain apertures (windows, doors, etc.), the present work evaluates by a cal-
culated means, the degree of penetration of radio waves through an aperture in
a ferroconcrete barrier. Calculations are made of the transmission coefficient
of decimeter waves through a rectangular orifice, the dimensions of which are
small in comparison with the length of the wave. These calculations show that
in the decimeter waveband, small dimensions of the aperture of $0.1\ \lambda$ and less
insignificantly contribute to penetration of radio waves through a ferroconcrete
well which contains thick wire grids (distance between wires in the grid, 20 cm).
The transmission coefficient through the wall with such an aperture depends on
the direction of arrival and the polarization of the incident wave, the coordinate
of the observation point and the orientation of the object on which the radio
waves react. The author thanks G. V. Kravtsov for helpful consultations and
N. N. Zav'yalov for help during calculations. Figures 5; tables 1;
references 4: 1 Russian, 4 Western.
[85-6415]

ANISOTROPIC SCATTERING OF RADIO WAVES OF SHORTWAVE BAND IN LOW IONOSPHERE OF
MIDDLE LATITUDES

NASYROV, A. M., STENIN, Yu. M. and TEPTIN, G. M., Kazan' State University

[Abstract] The results are given of the measurement of the characteristics of
E_H scattering in the shortwave band at a frequency (25 MHz) exceeding the maxi-
mum usable frequency, obtained during 1972-1976 on the Moscow-Kazan' middle-
latitude route. These characteristics are compared with the theoretical,
calculated with allowance made for the anisotropic inhomogeneities in the
geomagnetic field resulting because of the mechanism of turbulent agitation.

In order to detect foreshortened--scattering signals on the line Moscow-Kazan', transmitting and receiving antennas were expanded to the north from the arc of the great circle in the direction of an area of mirror scattering with reference to the vector of the geomagnetic field. However, scattering can take place during this, not only at magnetic-oriented but also isotropic inhomogeneities in the lower atmosphere. In order to introduce foreshortened--scattered signals in parallel, measurements were made on the route of forward scattering Archangel-Kazan' at a frequency close to that used on the Moscow-Kazan' route. The center of the Archangel--Kazan' route coincided with the region of the foreshortened-scattering on the Moscow-Kazan' line. As the result of a comparison of theory and experiment it can be shown that: 1) The theoretical evaluations obtained with assumptions concerning the turbulent mechanism of formation of inhomogeneities, allowing for the geomagnetic field in the lower ionosphere, agree well with experimental data for signals of type E_b; 2) The effect of the magnetic field of the earth on the characteristics of the E_b is not great as a result of the fact that scattering takes place at almost isotropic inhomogeneities. This gives rise to an increase of the interior scale of the turbulence and height, which leads to the fact that the principal portion of the signal is scattered at a range of height of 80-90 km; 3) The mechanism of turbulent scattering can not account for the experimental data with respect to the foreshortened--scattering of E_H type. Possibly this indicates the existence in the middle latitude ionosphere of other mechanisms for formation of inhomogeneities leading to scattering of a signal at heights greater than 110 km where there is anisotropic diffusion. It is possible that they are caused by current instabilities, with the aid of which formation at present of anisotropic inhomogeneities at high and equator latitudes is explained. This relates to anisotropic scattering at higher latitude, caused by the turbulent agitation discussed above. In principle they can be separated experimentally, if there are used lower operating frequencies and a narrow-beam antenna in a vertical plane, oriented to the foreshortened region at a height of more than 110 km. Use of narrow-beam antennas makes it possible to exclude isotropic scattering at a height of 80-90 km and use of low frequency makes it possible to compensate for the depletion of small scales in the spectrum of inhomogeneities caused by an increase of the height of the interior scale of turbulency. Figures 5; tables 1; references 14: 13 Russian, 1 Western.
[115-6415]

DIGITAL INTERPOLATION OF RESULTS OF MEASURING AMPLITUDE-PHASE DISTRIBUTION
OF ANTENNA SYSTEM FIELD

VIL'KOTSKIY, M. A. and LICHKO, G. P.

[Abstract] Together with the use of interpolation in communication technology, during analysis of speech and processing of images, the necessity appeared for

interpolation of the results of measurement of the amplitude-phase distribution (APD) of the field of antenna systems in the near zone. In order to decrease the volume of the initial measurement data of the APD of the field, a spatial quantization was made with the maximum possible spacing frequently artificially condensing these data with the aid of various methods of filtration. Inasmuch as the algorithm of the rapid Fourier transform (RFT) used has the ability to retain a solution in the spatial region, the number of selections in the quantified representation of APD after processing with the use of RFT does not change. At the end of processing APD at an alphabet-digital printing device (ADPD) the initial quantity of points in the spatial region does not make it possible to obtain a picture complete for visual observation because of the large spacing of spatial quantization. Interpolation is also necessary during derivation of limited sections of APD, of interest for an observer for example of flaw detection of antenna systems with an increased number of readouts in specified sections of RFT. The present report considers the interpolation of the results of measurements of RFT, effected with the aid of digital filters. A photograph is shown of the module of a RFT antenna array with a defect in the form of 40 slits closed by a metal plate, the coordinates of which are recorded. Interpolation in a 2 x 2 times RFT is represented in a second photograph. As is seen, perception of the results of measurement of AFF after interpolation is improved, which makes it possible visually to determine precisely the proposed region of the flaw. Figures 2; references: 3 Western (1 in translation). [89-6415]

BOUNDARY EFFECTS IN STRIP STRUCTURE WITH ARBITRARY WAVE SLIP ANGLE. WAVES IN MICROSTRIP WAVEGUIDE

ZAYTSEV, S. V. and FIALKOVSKIY, A. T.

[Abstract] A quantitative analysis is made of the reflection coefficient of a TEM wave with an arbitrary wave slip angle $0 \leqslant \zeta \leqslant \pi/2$. An analytical expression for the reflection coefficient is obtained from the general formulas in a 1975 work by A. T. Fialkovskiy (see above). In the particular case with the normal incidence $\zeta = \pi/2$, the results agree with those known. The analytical expressions presented make it possible to investigate the boundary effects in strip structures with an arbitrary slip angle, and passage through a critical point, at which with an increase of the slip angle the surface wave is regenerated into a resultant, and the resultant waves with n = 0 and $0 \leqslant kd \leqslant \pi$. The propagation constant, the diffraction losses and the wave resistance of a microstrip waveguide are studied. The expressions derived in the work can serve as the basis for calculation of a radiation pattern and the agreement of elementary radiators in integral accomplishment--elements of phased antenna arrays. Figures 6; references 14: 12 Russian, 2 Western.
[116-6415]

NOISE IMMUNITY OF CORRELATION-TYPE RECEIVER OF OPTICAL SIGNALS WITH
PHASE-DIFFERENCE MODULATION

BORISOV, E. V.

[Abstract] It is possible to realize phase-difference modulation (PDM) in the
optical frequency range by modulation of subcarrier oscillations, which in turn
modulate the optical carrier with respect to the intensity (PDM-IM). In the
present work an evaluation is given of the noise immunity of the correlation-
type receiver of such signals. Graphs are presented which can be put to use
for evaluation of the potential noise immunity of a correlation-type receiver
of PDM-IM. References: 2 Russian.
[112-6415]

ALGORITHM OF DETECTION OF SIGNALS ON MULTIMODE CORRELATION INTERFERENCE
BACKGROUND

BAKULEV, P. A. and KOVAN, S. Ye.

[Abstract] The problem is considered of radar detection of a coherent signal
with an unknown amplitude and random initial phase on a background of normal
interference with a multimode spectrum and unknown correlation properties.
It is considered that the multimode interference is produced as a set p of
independent stationary components which can have various spectral characteristics.
Figures 2; references: 2 Russian, 1 Western in translation.
[112-6415]

ANALYSIS OF INSTABILITY OF LINEAR OPTOELECTRONIC DECOUPLERS

ABDULLAYEV, A. A., NOSOV, Yu. R. and MAMEDOV, A. K.

[Abstract] Recently devices based on optrons have been used for transmission
of analog signals through a galvanic isolation network. Such linear opto-
electronic decouplers (OD) have a number of obvious advantages as compared with
traditional amplifiers with inductive coupling, the most important of which is
their technological compatability with integrated circuits. One of the princ.-
pal performance figures of similar devices is stability. In the present paper
the results are presented of the analytical investigation of the temperature
instability of the transfer constant and the "null" of the output voltage of
an OD with a differential optron. A block diagram is presented and explained.
Figures 2; references: 3 Russian.
[85-6415]

MULTIDIMENSIONAL DISTRIBUTION OF ENVELOPES DURING ARBITRARY FLUCTUATIONS OF
RADIO SIGNALS AND INTERFERENCE

CHABDAROV, Sh. M.

[Abstract] During planning and calculation of radio lines and the equipment
for radars, navigational, and other radio systems with mobile objects, and in
many other cases, a multidimensional probability density of the voltage at the
output of a detector is necessary in the case of arbitrarily assigned fluctua-
tions of signals and interference at the receiver input. Such expressions are
absent in the literature; they are known only for the envelope of a Gaussian
process, the sum of the determinate signal and Gaussian noise. In a 1978
report, these results are used in semigaussian methods of analysis of the passage
through an intermediate frequency amplifier and a detector of the signal, and
arbitrary noise. However, the known formulas are inconvenient for calculation
because the multiple indices coming into them, by which a multiple summation of
a corresponding series, not indicated in an obvious form, is conducted. These
formulas in practice do not involve important cases of interaction of signals
and interference with various fluctuations. The absence of a similar distribu-
tion restrains the development of theory and practice of an optimum noncoherent
process of complex signals. A figure is shown of the probability density
calculated in the literature for two readouts of the envelopes for the same

parameters of a signal, interference and noise. The present work obtains a multidimensional probability density of envelopes on the basis of semigaussian models of the quadrature components of the readouts of the interfering input oscillations. This is used to obtain rigorous and engineering formulas with the presence and (or) absence of internal coherency and various linked signals and interference. Figures 1; references 11: 8 Russian, 3 Western. [85-6415]

POSSIBILITY OF RECEPTION OF WIDE-BAND OSCILLATIONS OF EXTRATERRESTRIAL SOURCE OF RADIO EMISSION WITH AID OF PHASED-ARRAY ANTENNA

MAKSAKOV, N. F., SOKURENKO, V. L. and KHRUPALO, A. A.

[Abstract] Problems of the practical use of phased-array antennas (PAA) are sufficiently fully defined for signals with a spatial correlation inter al, substantially exceeding the dimensions of the receiving aperture. In fact, the relationship between the correlation time and the lag at the apertures can be arbitrary, which is brought about by the conflicting trend observed in recent years of increasing the wide-band oscillations and the use of antennas with large geometrical dimensions. This trend stimulated intense investigations of problems arising during this--one of which is the reception of signals of an extra-terrestrial source of radio emission with a time lag at the aperture with a much larger magnitude of the reverse frequency band. The present paper investigates the possibility of a solution of such problems with the presence of an equidistant PAA. The space-frequency properties of a PAA are analyzed. A block diagram is shown of a device, at the basis of the functioning of which is the method considered in the paper for space-time processing, and the device is explained. A method is considered for compression of the output signal of a PAA with respect to the angular coordinate in order to increase the precision and resolution. Figures 4; references 6: 4 Russian, 2 Western in translation. [89-6415]

NOISE IMMUNITY OF SIGNAL TRANSMISSION WITH DIFFERENCES AND DELTA-DISCRETE CONCEPTS

NOVOSELOV, O. N. and FOMIN, A. F.

[Abstract] Even though there is an extensive literature concerned with digital systems, at present there is lacking an analytical, rigorous and adequate comparison of the noise immunity and effectiveness of digital systems of transmission with the use of different (differential pulse-code modulation), delta modulation and other discrete concepts. The present work considers these omissions and a further investigation of the noise immunity of digital transmission systems is made. It is shown that the most interference immune of the systems considered are transmission systems with difference discrete representation (systems with differential pulse-code modulation). In the course of restoration by means of interpolation by polynomials of low degrees, the gain from the use of different concepts with respect to the threshold power signal-to-noise ratio may amount to 3-4 dB in comparison with representation by selections during which a reduction is also achieved simultaneously by the system of the engaged frequency band. Systems with delta-representation (with delta modulation) with respect to noise immunity occupy an intermediate position between systems with different representations and representations by selections, during transmission of all the forms of the procesess considered. A non-differentiable process is an exception, during transmission of which, systems with delta-representation are inferior with respect to noise immunity and with respect to the system of the frequency band of the other systems which are considered. Transmission of reference selections (with respect to one at the correlation interval of the communication) does not lead to a noticeable increase of the widebandness of the system. Figures 2; references 7: 6 Russian, 1 Western in translation. [85-6415]

EVALUATION OF EFFECTIVENESS OF COHERENT-WEIGHT PROCESSING WITH LIMITED DYNAMIC RANGE OF RECEIVER

[Abstract] Contemporary systems make it possible to organize interference, the power of which exceeds the dynamic range of real receiving devices of radars. The nonlinearity of the amplitude characteristics appearing in this case substantially transforms the statistical properties of the interference, which in turn leads to a noticeable difference of the real effectiveness of optimum

systems of coherent-weight processing of existing theoretical evaluations, obtained without taking account of the effect of the limitedness of the dynamic range. The tendency to increase the adequacy of the theoretical evaluations of the noise immunity of radar stations causes urgency in the development of methods for obtaining them, taking into account the nonlinearity of the amplitude characteristics of real receivers. In the present paper the traditional method of evaluating the effectiveness of systems of coherent-weight processing is reviewed and a method is proposed for such an evaluation with the presence of interference in the form of a blend of thermal noise and interfering reflections, in this case taking into account the effect of the limitedness of the dynamic range of the receiver. Figures 1; references 5: 2 Russian, 3 Wester: (1 in translation).
[89-6415]

621.396.23

UDC 621.396.23

EFFECTIVENESS OF DISCRETE CONTROL OF INFORMATION TRANSMISSION RATE IN RADIO LINES WITH SIGNAL FADING

Moscow RADIOTEKHNIKA in Russian Vol 36, No 7, Jul 81
(manuscript received after completion 5 Sep 80) pp 34-36

PAKHOMOV, I. S. and POSTYUSHKOV, V. P.

[Abstract] A 1976 report from the literature considers an algorithm of continuous control of the information transmission rate on radio lines with signal fading. The effectiveness of such control was evaluated with the aid of the gain in the average information rate. In real systems, it is extremely diffi-cult to achieve continuous control, which is explained by the necessity for rigorous synchronization of the receiving and transmitting stations. Consequently, from the point of view of practical realization, discrete control of the transmission rate is preferable. In addition, the user is interested not only in the rate, but also the opportunity for information transmission. The present work evaluates the gain in the average rate and the probability of timely information transmission with discrete control of the transmission rate. An algorithm for this purpose is formulated. It is shown that the gain with dis-crete control is approximately 2 to 3 times smaller than with continuous control. Consequently, control of the information transmission rate makes it possible substantially to increase the effectiveness of radio lines with fading of signals. Figures 2; tables 2; references 4: 3 Russian, 1 Western in translation.
[85-6415]

OPTIMIZATION OF PARAMETERS OF ANTENNAS WITH POLARIZED SELECTION OF SIGNALS IN MULTIPATH CHANNEL

GOLOVIN, E. S.

[Abstract] The paper evaluates the gain in suppression of the intensity of multiplicative interference of multipath channel mobile radio systems of extra-high and ultra-high frequency, by means of a polarizing selection of the reflected waves of elliptically polarized antennas. It is concluded that an optimum polarization selection assures a better signal-to-interference ratio at the input of the receiver than a matched solution, because in any multibeam arrangement it is possible in practice to supply such parameters of the polarization ellipse of an antenna in which the amount of decrease of the power of a completely polarized component of the interference is larger than the gain of the signal power in comparison with a variant of a matching antenna and signal with respect to polarization. Figures 4; references 6: 5 Russian, 1 Western.
[89-6415]

ERRORS OF PHASE SYSTEMS OF VERY LONGWAVE NAVIGATION UNDER AURORA PERTURBATION CONDITIONS

BELOGLAZOV, M. I.

[Abstract] Evaluations are experimentally obtained for the root-mean-square errors σ_r of position determination in phase very longwave navigation systems, for quiet and perturbation ionospheres. It is shown that the magnitude σ_r in the far zone at distances of $\sim(6 \div 7)$ thousand kilometers is approximately 5-6 times larger for high latitudes than for medium. In the near zone (at a distance of approximately 1000 km), σ_r of the aurora region is two times larger for quiet conditions and four times larger for perturbation as compared with middle latitudes. Figures 1; tables 1; references 5: 3 Russian, 2 Western (one in translation).
[85-6415]

INVESTIGATING EFFECT OF INSTABILITY OF GENERATOR FREQUENCY ON EFFECTIVENESS
OF SIGNAL DETECTION IN COHERENT RADAR

PLEKIN, V. Ya.

[Abstract] In coherent radar, during detection of signals on a background of
correlated interference, interperiod processing is used, which achieves "between
period" subtraction (BPS) of interference and build-up of the useful signal.
However, the effectiveness of interference suppression and detection of signals
in a radar with interior coherence significantly depends on the instability of
the frequency of local and coherent oscillators. The present work proposes a
method of calculating the detection characteristics of a system for selection of
moving targets in a pulse radar with interior coherence and phasing at inter-
mediate frequency, taking into account the effect of instability of frequency
of local and coherent oscillations. The statistical characteristics are con-
sidered of the signals and interference at the output of a single-stage system
of BPS. Figures 1; references: 6 Russian.
[85-6415]

SOME SPECIAL FEATURES OF ULTRASHORT-RANGE SCANNING ANTENNA ARRAYS

SOVETOVA, L. N. and SHMELEV, Yu. D.

[Abstract] This report considers the special features of scanning in the
elevation plane of antenna arrays of the ultrashort range with the phase dis-
tribution "0--π", taking into consideration the effect of electromagnetic waves
reflected from the earth. A quantitative evaluation is made of the antenna
array during scanning. Curves are shown of the basic diagram, and diagrams of
the third and fifth order, respectively. It is concluded that in the case of
realization of the variable plane method of scanning with the use of a signal
reflected from the earth, supplementary side lobes make their appearance in the
diagram, the magnitude of which does not depend on the general amplitude dis-
tribution of the excitation along all the arrays. The level of the supple-
mentary side lobes depends on the distribution of excitation along the half
period. Their angular position is determined by a relation derived in the work
and depends on the length of the half period. The optimum distribution along the
half period is sinusoidal, because in this case the supplementary side lobes also
lack the maximum level of fringe radiation, and as in systems with ordinary phase

scanning depends on the amplitude of the distribution in the array. The authors thank A. R. Vol'pert for assistance in stating the problem and for nelpful discussion of the results obtained. Figures 4; references 3: 2 Russian, 1 Western.
[89-6415]

DESIGN OF CORRELATOR WITH SPECIFIED LEVEL OF SIDE LOBES OF CORRELATION OF OUTPUT SICNAL

KOZLOV, I. A. and PARSHIN, Yu. N.

[Abstract] The results of processing complex wide-band signals with a large base, which have a spectrum close to rectangular, are connected to a consider- able degree with an output signal (correlation function) with a low level of side lobes obtained at the output of a matched filter or a correlator. The presence of appreciable side lobes on both sides of the base leads to a loss of weak signals masked by the side lobes of a strong signal, particularly during observation with the assistance of a radar or a large number of targets which have a wide dynamic range of reflecting surfaces. The side lobes can cause a false alarm in the case of reflections, ambiguity of evaluation during measurement of delays and other undesirable phenomenon. In the present paper a block diagram of the correlator is presented and a description of its operating principles is furnished. The calculations of the side lobes of the correla- tion function, presented in a table, based on an approximation of the Dol'f- Chebyshev function, are obtained for signals with a rectangular form of spectrum. However, it is also possible to obtain good results with some difference of the spectrum form from the rectangular, e.g., in the case of processing discrete frequency-manipulated signals. Figures 2; tables 1; references 4: 2 Russian, 2 Western (in translation).
[89-6415]

BROADCASTING, CONSUMER ELECTRONICS

UDC 53.088.6

CORRECTION OF CHARACTERISTIC NONLINEARITIES OF MEASURING FREQUENCY—TIME
SCANNING CONVERTERS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian
Vol 24, No 8, Aug 81 (manuscript received 20 Nov 80) pp 20-24

BONDAR', N. M., Moscow Aviation Institute imeni Sergo Ordzhonikidze

[Abstract] The problem is considered of developing a simpler and more general-
purpose method of correcting the nonlinearities of a frequency—time scanning
converter (FSC), dependent upon transducers of source information. The block
diagrams (Figure 1), the corresponding conversion methods considered, and the
form of nonlinearity in the circuits of the transducer are constructed on the
basis of generalized structures of FSC. The block diagrams of the open in-
variant measuring devices are in accordance with the expressions presented in
a table. A block diagram (Figure 2) is presented of a linear parametric con-
verter of resistance into frequency of the output signal. Dependences are
derived for a choice of the characteristics of correcting transducers with
various methods of conversion and form of nonlinearity. Figures 2; tables 1;
references: 6 Russian.
[125-6415]

UDC 538.56:519.25

PROBLEM CONCERNING SPECTRUM OF FREQUENCY-SHIFT KEYING SIGNAL

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 24, No 9, Sep 81 (manuscript received 7 Jul 80) pp 1131-1136

DUBKOV, A. A. and MAL'TSEV, A. A., Gor'kiy State University

[Abstract] In a 1979 work by the authors, the spectral density is found of
oscillations, modulated with respect to frequency, by a Markov stationary
telegraph process. In the present work, an extension is made of the results
obtained earlier, for the case of the frequency—shift keying process, the

moments of the skip effect of which form a stationary flow of restoration.
A basic formula is derived which makes it possible to determine with precision
the form of the spectra of the frequency-shift keying signals for a wide class
of probability distributions of the values being received and the intervals
of switching of the modulating process. References 7: 5 Russian, 1 Western.
[116-6415]

ONE DISCRETE DISTRIBUTION OFTEN APPEARING IN RADIO ENGINEERING PROBLEMS

POBEREZHSKIY, Ye. S. and SOKOLOVSKIY, M. N.

[Abstract] Discrete random magnitudes, distributed one at a time in accordance
with an earlier law, not investigated, are often encountered in radio engineer-
ing. In the present work three examples of such magnitudes are presented and
expressions are found for a common term of a series and the numerical charac-
teristics of a given distribution which simplifies the solution of many radio
engineering problems. Figures 1; references: 4 Russian.
[89-6415]

CALCULATION OF CHARACTERISTICS OF TIME DISCRIMINATOR WITH ELIMINATION OF
DOPPLER AMBIGUITY OF INPUT SIGNAL FREQUENCY

RYLOV, V. I. and TEREKHOV, A. L.

[Abstract] During reception of phase-code manipulated signals, the problem
often arises of automatic tracking of their time delay, i.e., automatic search
for a signal with respect to delay and synchronization of the receiving device.
Tracking delay devices are mostly fulfilled in the form of a conventional system
of automatic regulation with a correlation discriminator, a block diagram of
which is shown. However, the problem of synchronization is often complicate
by the presence of a Doppler ambiguity of the frequency of the signal received.
In this case, during construction of a discriminator it is possible to use the
same principles as above but with the introduction into each arm of the dis-
criminator of N channels with narrow-band filters, which overlap all the range
of possible frequencies of the signal received. A block diagram of this
arrangement is presented. The method, the assumptions made and the results

are presented of a calculation of the discriminator characteristics of a corre-
lation discriminator with multiband processing of a FM signal convoluted with
respect to the spectrum. The authors thank their scientific advisor,
Al'batsa, M. Ye. [deceased]. Figures 4; references: 1 Russian.
[112-6415]

QUALITY CONTROL OF TELEVISION RECEPTION BY TEST LINES METHOD

BABUK, G. V., VILENCHIK. L. S. and DUBINSKIY, L. M.

[Abstract] Experimental investigations were made of the quality of television
reception in areas of high build-up, conducted with the aid of test line
signals, radiated by a transmitter and a Nyquist control demodulator. It is
shown that the quality of television reception under specific conditions can
be objectively evaluated by a through control of a section of a television
broadcasting channel from the input of a transmitter to the output of a recep-
tion antenna, during which it is advisable to employ test signals radiated by
a transmitter with the necessity to normalize their total distortion in a section
of the channel. With the use of control demodulators with a linear amplitude
detector, it is necessary to select the total amplitude of the test signals
intended for control of linear distortions equal to 0.4-0.5 of the amplitude of
a brightness signal from the level of black up to the nominal level of white.
It is preferable to use control demodulators with synchronous detection, with
which it is possible to use test signals of total amplitude. Figures 3;
references: 2 Russian.
[112-6415]

PRINCIPAL CRITERION FOR CHOICE OF REFERENCE TELEVISION SYSTEM

NOVAKOVSKIY, S. V. and MAMEDOV, I. R.

[Abstract] The paper is concerned with systems for transmission of supplemental
information (SI) in television broadcasts. Such systems are communication
systems which deliver information to the recipient in the form of images of
texts reproduced on a television screen with the use of parts of its circuit and
a special device--a terminal (attachment to television). Passive and interactive

systems of SI are considered and a comparative analysis of these systems is made. The following items are discussed; 1) Passive system of transmission of SI with time multiplex; 2) Interaction of transmission system of SI; 3) Comparative analysis and recommendations with respect to construction of systems of reference television. Figures 3; tables 1; references 4: 2 Russian; 2 Western.
[89-6415]

ACCURACY OF DEPTH MEASUREMENT WITH STEREOSCOPIC TELEVISION SET

MAMCHEV, G. V., Chair of Television, Novosibirsk Institute of Electrical Engineering of Communications

[Abstract] Determination of the depth dimension of an object through a stereo-scopic television transmitter-receiver set is quite inaccurate, because of an inevitable error in visually projecting any element of the object onto the depthwise nearest scale segment. The accuracy can be improved by means of an electronic visor. Images of two aspects of the object appear respectively in the two transmitter cameras, where they are converted to electric signals. At the receiver end these signals are converted to images which appear on the respective screens of the stereoscopic CRO pair with spatial selection. The visor is formed by means of two driven multivibrators triggered by line synchroni-zation pulses and in turn triggering the two generators of strobe pulses for the images in the stereoscopic pair. The strobe pulses are perceived as a vertical visor in 3-dimensional space and can be visually superposed on any element of the perceived object. An arithmetic unit, furthermore, converts parallax to depthwise distance between an element of the object and the plane in which the optical axes of the transmitter cameras converge. An evaluation of the image analysis and synthesis, taking into account the system geometry as well as systematic and random errors, indicates that the error of depth measure-ment can in this way be reduced from 10 to 1%. Figures 2; references 6: Russian.
[135-2415]

21

TOPOLOGICAL INTERRELATIONSHIP OF AMPLIFYING DEVICE STRUCTURES WITH ADDITIVE CORRECTION OF DISTORTIONS

VOLGIN, L. I.

[Abstract] The present work is concerned with the establishment of topological interrelationships between the structures of amplifying devices with additive correction distortions. This makes it possible to demonstrate the completeness of the classes of structures considered and to extend the results of the analysis of any circuit for all those remaining, connected with producing the circuits of topological conversions. On the other hand, the procedure presented for series topological conversion gives the developer an effective algorithmic means of "multiplication" of the circuits of radio engineering devices. It is shown that the closed sequence of I- and N-transformations of the class of structures considered is broken into two characteristic subclasses. It is noted that the methods of topological synthesis have not yet obtained sufficient development within the limits of the theory of active electrical circuits. Meanwhile, their value is difficult to reestimate. In fact, the problem of developing new circuits which is traditionally solved by heuristic means with the use of topological methods, boils down to an algorithmic conversion of the initial (origin) circuit. This in turn gives rise to a reason for machine synthesis of new circuits in an automatized search for optimum circuit solutions. Figures 1; references 22: 19 Russian, 1 Hungarian, 2 Western in translation. [89-6415]

QUASI-MEANDER

L'VOVICH, A. A. and KUZ'MIN, B. D.

[Abstract] Devices for digital synthesis of frequency, achieved on the basis
of integrated circuits, are widely utilized in electronic equipment. Problems
of synthesis of frequencies and synthesis of multilevel stepwise pulse sequences
with the use of digital microcircuits are typical in the creation of many forms
of such equipment. During a solution of the problem of optimizing synthesis,
the necessity was established for a new, special system of basic functions,
quasi-meanders, which, having the form of an effectively achieved two-level
pulse sequence (TLPS), would satisfy a number of conditions which are described
in the present work. The authors note that TLPS of the form quasi-meander are
sometimes considered under other names, e.g., conditionally-optimum sequence,
smooth sequence, and without a special name. The basic functions are intended
for synthesis of frequencies as well as synthesis of consecutive multiequation
oscillations by means of a weighted summations of the functions. The present
work considers the characteristics of quasi-meanders, and data are presented
concerning the composition of these functions, in particular concerning the
satisfaction by them of the monofrequency condition, which is particularly
important during solution of many problems concerned with synthesis of frequency.
Figures 3; tables 4; references 14: 11 Russian, 3 Western.
[85-6415]

SYNTHESIS OF DIGITAL FILTER-DEMODULATOR BASED ON BINARY FAST FOURIER TRANSFORM

VITYAZEV, V. V. and STEPASHKIN, A. I.

[Abstract] A 1979 report, the principal author of which is V. V. Vityazev
(see above), considers synthesis of the structure of a set of digital filter-
demodulators (DFD) for systems of narrow-band filtration in a class of circuits
with pulse characteristics of finite duration, and shows that one of the possible
methods of realization is an algorithm on the basis of a binary fast fourier
transform (FFT), the effectiveness of which with respect to the method of direct
convulation substantially increases with truncation of a discrete amplitude-
frequency characteristic (AFC) outside the scope of the pass band for a filter-
demodulator. Quantitative evaluations are presented for the effectiveness of a
method of binary FFT and the structure of device which is synthesized at the

functional level. However, the effect of truncation of a discrete AFC on the precision of filtering and some specific characteristics of an algorithm of a binary FFT, as applied to the problem of synthesis of a DFD, important for developers, is not taken into account in the 1979 work. The present paper makes up for this omission. Figures 2; references 4: 2 Russian, 2 Western (1 in translation).
[85-6415]

IMPROVEMENT OF CALCULATING TECHNIQUE FOR EQUIVALENT CIRCUIT OF PRECISION MONOLITHIC QUARTZ FILTERS

YUKHNO, I. N.

[Abstract] From a constructional viewpoint monolithic quartz filters (MQF) are thin quartz plates, on the opposite sides of which several pairs of metal electrodes of a specified form and thickness are applied. The equivalent circuit of a MQF obtained with the use of an electromechanical analog is shown. The present paper works out a refinement of the calculation procedures normally used. The experimental improvements showed a sufficiently high precision of the accepted calculation method and made it possible to use a computer frequency during planning of precision MQF. Figures 3; references 6: 5 Russian, 1 Western in translation.
[85-6415]

FUNCTIONAL ADJUSTMENT OF PRECISION MONOLITHIC QUARTZ FILTERS

BOROVINSKAYA, D. A., KRIVOSHEYKIN, A. V. and YUKHNO, I. N.

[Abstract] Monolithic quartz filters (MQF) are a variety of electro-mechanical filters. Structuaally, MQF are fulfilled in the form of thin quartz plates varying with respect to thickness and with applied pairs of electrodes. The equivalent circuit of a four-resonator monolithic quartz filter is shown in the present work. Precision MQF (PMQF) are filters, on the parameters of which extremely rigid requirements are imposed. The stages of functional adjustment of PMQF are described, and the necessity for functional adjustment is substanti-ated. As an example, using a method stated in a 1975 report, the parameters

are calculated of the equivalent circuit of a MQF. Figures 2; tables 1;
references: 8 Russian.
[112-6415]

TEMPERATURE STABILITY OF 'BEYOND THE BOUNDS' WAVEGUIDE-DIELECTRIC FILTERS

KAPILEVICH, B. Yu. and FEDOTOVA, T. N.

[Abstract] Band-pass filters based on "beyond the bounds" (BB) waveguide-
dielectric structures are more and more widely used in microwave technology.
However, questions regarding the temperature stability of the electrical param-
eters of such filters have been insufficiently studied. The present work con-
siders this problem, using as an example a two-unit waveguide-dielectric filter,
which consists of a rectangular waveguide of a reduced width with symmetrical
dielectric connections which have different dielectric constants ϵ_1 and ϵ_2.
Parts of the waveguide with a dielectric constant ϵ_1 and a BB for a fundamental
wave at the operating frequency. At the parts of the waveguide with a dielec-
tric constant ϵ_2 the H_{10} wave is propagated. The results of the experimental
investigation of the temperature characteristics of the filters are presented
in graphic form. The dependences of the drift of the resonance frequencies of
the filters on the temperature for two-unit filters with different fillings
are shown. Figures 3; references 5: 1 Russian, 4 Western.
[85-6415]

EXPANSION OF LOCKING BAND OF OSCILLATOR LOCKED-IN AT SUBHARMONIC FREQUENCIES
OF AUTO-OSCILLATIONS

KATUSHKINA, V. M., MALYSHEV, V. P., NIKITIN, A. B. and SHALAPANOV, A. V.

[Abstract] Use of a complicated oscillating system, the phase-frequency
characteristics of which have a minimum change of phase in a specified frequency
range, makes it possible significantly to expand the lock-in band of a solid-
state microwave oscillator locked-in at a fundamental frequency. The present
paper experimentally investigates the possibility of expanding the locking band
at a subharmonic microwave oscillator using a Type 3A703A,B Gunn diode with a
complicated oscillatory system formed with the assistance of a circuit of a

supplementary operational system of high frequency. Figures 3; references:
4 Russian.
[89-6415]

SOME SPECIAL FEATURES OF INTEGRAL PULSE-DURATION MODULATION

POPOV, V. V. and SKOKOV, A. I.

[Abstract] The paper considers a Class D power amplifier fulfilled in the form
of a pulse-duration system (PDS) consisting of a quantizator which accomplishes
conversion of the input signal into a modulated sequence of pulses, and the
linear part. It is assumed that linear part of the system is a single-section
of a Γ-shaped LC-filter loaded with the resistance $R = \sqrt{L/C}$. Moreover, it is
assumed that the input signal $e(t)$ has an arbitrary nature with a frequency
spectrum limited by the frequency Ω_s. Synthesis of the modulation will be
realized on the basis of an analysis of the input signal during the timing
interval T_i of modulation without taking account of the previous values of the
signals. Figures 2; references: 3 Russian.
[112-6415]

MACROMODEL OF COMBINATION TYPE DIGITAL INTEGRATED MICROCIRCUITS

DEMIRKHANYAN, ADOL'F MIKHAYLOVICH, senior instructor, Yerevan Polytechnical
Institute

[Abstract] At present a large number of programs for modeling electric circuits
at the level of radio components have been developed. However, these programs
can be used effectively, only during planning of integrated microcircuits (IMC)
of small or (in the best case) average degree of integration. Modeling of IMC
containing thousands of elements at the radio components level is done up to
the present with difficulty because of the limited potentialities of both
contemporary digital components and operating programs. A solution of the
problem is presented in the break down of the electrical circuit of a large
integrated circuit (LIC) into subcircuits which furnish the basic elements of
the system. Modeling at the level of logical gates with allowance made for
load and operational factors is based on presentation of the object being

modeled as a "black box" and develops as applied to a description of logical elements in two basic directions; 1) Logic equation of the connection of input and output variables; amplitude characteristics and characteristics of output of the dynamic parameters assigned as a function of the factors taken into account; and 2) The electrical equivalent circuit imitating the form of a real signal at the output. The general and most significant shortcomings of such models are: the impossibility of solution of the problem of parametric optimization, complexity of taking into account the effect of destabilizing factors in view of the nonphysicalness of the model, the insufficient compactness in the region of applicability, and the difficulty of taking into account the specific properties of real IMC (e.g., the presence of interior memory). These problems can be solved by construction of macromodels on the basis of an analysis of the physical processes occurring in the circuit, which leads to the necessity for a preliminary analysis of the modeling circuit; taking into consideration, however, the limitedness of the assembly of fund mentally different circuit realizations of logical elements it is possible to neglect these shortcomings, because summing up we have physically well-founded macromodels of broad application. The present paper is devoted to the development of such an approach to macromodeling. Block diagrams are presented of 1) Active multi-terminal network with a piecewise linear approximation of the volt-ampere characteristics of its terminals, which serves as the basis of a macromodel; and 2) A statistical model of a large element with n inputs and one output. In order to evaluate the precision of modeling, macromodels of two types of logic elements with standard electrical parameters were tested on a digital computer. The results of a comparison of the statistical and dynamic functional characteristics, obtained experimentally and on the basis of tests of a macromodel on a digital computer, are shown in tabular form. The proposed macromodel of a logical element can be used successfully both for design automation of large digital systems of combination type and for automation of the determination of the functional characteristics of finished articles. The macromodel sets up wide possibilities for calculation of all kinds of destabilizing factors. The macromodel can be included in the form of a subprogram of a component in a general program of analysis of electronic circuits. The macromodel assures a satisfactory precision of modeling. Figures 2; tables 2; references 8: 6 Russian, 2 Western (in translation).
[134-6415]

27

COMMUNICATIONS

EVALUATION OF TRANSMISSION QUALITY OF CROSSHATCH IMAGES IN DIGITAL FACSIMILE
WITH COMPRESSION

ALPERIN, Ye. D. and KRETININ, V. V.

[Abstract] The possibility is considered of using the criterion of symbol
legibility for analysis of the noise immunity of facsimile systems. On the
basis of experimental investigations described in the literature, three typical
types of symbol distortions were selected: 1) Black band; 2) White band; and
3) Shift of elements of image. These are shown in a figure. The results of
the investigations are given in four tables. On the basis of these results and
with respect to the criterion of symbol legibility, an analysis is made of
digital facsimile systems and their objective comparison. Figures 2; tables 4;
references 12: 8 Russian, 4 Western.
[112-6415]

INVESTIGATION OF EFFECT OF LOAD ON CHARACTERISTICS OF SYNCHRONIZED GENERATOR
BASED ON AVALANCHE TRANSIT TIME DIODE

YANEV, A. S., ANGELOV, I. M. and SPASOV, A. Ya., Peoples' Republic of Bulgaria

[Abstract] A synchronized generator based on an avalanche transit time diode
(GATD) is investigated, employing the method of nonlinear conversion of
variables during calculations, which makes it comparatively easy to take into
account the nonlinearity of the complex impedance of the ATD. The fundamental
equations of a synchronized GATD, and the characteristics of a synchronized
generator based on an ATD are studied. Construction is presented of the coaxial-
waveguide generator investigated. It is shown that the characteristics of a
synchronized generator using an ATD substantially depend on the power of the
synchronizing signal and the load resistance. The results of an experiment in
the 3-cm microwave range are presented. For a number of applications of syn-
chronization, a load is necessary which differs from that which maximum power is
obtained in an autonomous regime. Figures 3; tables 1; references 5: 3 Russian,
2 Western.
[89-6415]

ELECTRICAL INSULATION

ELECTRICAL STRENGTH OF LIQUID DIELECTRICS UNDER MICROSECOND VOLTAGE PULSES

KUCHINSKIY, G. S., LYSAKOVSKIY. G. G. [deceased], MONASTYRSKIY, A. Ye. and
VYCHUZHIN, N. A., Leningrad Polytechnic Institute imeni M. I. Kalinin;
PECHERSKIY, O. P. and SMIRNOV, L. V., Scientific-Research Institute of Electro-
physical Apparatus imeni D. V. Yefremov

[Abstract] An experimental study was made in order to determine the electrical
strength of distilled water and transformer oil under microsecond voltage
pulses in a uniform electric field. Exponentially rising pulses of $1.6{\pm}0.2$ μs
duration were applied from a standard 55-60 kV discharger to a pair of stainless-
steel plane electrodes with round edges. Breakdown of the liquid was found to
occur with a 1.3-1.6 μs lag. The electrode area (S) as well as the interelec-
trode distance (d) were varied, and the electric field intensity at breakdown
was measured each time. Furthermore, cylindrical spacers made of various solid
dielectric materials such as acrylic glass, caprolon, and high-impact low-
(water)absorption compounds were inserted between the electrodes, to test their
effect on the electrical strength of the surrounding liquid. An evaluation of
the results of step-by-step tests with unipolar single strokes has yielded the
relation $E_{bd} = f(S,d) = 300\tau_{0.63}^{-1/3}(Sd)^{-1/10}$ kV/cm ($\tau_{0.63}$ time constant of exponential
voltage pulse) for water over the ranges d = 0.5-5 cm and S = 5-700 cm^2, and an
about 1.5 times correspondingly higher electrical strength for transformer oil.
The presence of a solid dielectric was found to lower the electrical strength
of transformer oil by approximately 10%, probably caused by local surface effects,
but not to affect the electrical strength of water. A probability analysis of
multiple breakdown has yielded a statistical distribution of electrical strength
with a standard deviation σ/E_{bd} of the order of $0.1E_{bd}$ and decreasing with in-
creasing interelectrode distance for water. No strength "compounding" was noted
in transformer oil, but a random fluctuation of the breakdown voltage about its
first level. Figures 3; tables 3; references 7: 4 Russian, 3 Western.
[137-2415]

OSCILLOGRAPH TUBES

Moscow RADIO in Russian No 9, Sep 81   pp 73-76

[Article by M. Gerasimovich, with materials prepared by G. Shul'gin]

[Text] Our domestic industry is producing a wide assortment of oscillograph tubes
intended for use in cathode-ray oscillographs and other instruments where it is
required to represent graphic information concerning various electronic processes.
Table 1 presents the basic construction features of the most widely used oscillo-
graph tubes. The parameters of the cathode-ray tubes and their range of operating
conditions are presented in tables 2 and 3; dimensions and pin-connection diagrams
are shown in the figures.

Design Features and Function of Oscillograph CRT

CRT Type	Screen Shape	Number of Projectors	Arrangement of Base Pin*
3L01I	Round	One	RSh31
5L038I	Round	One	RSh19
6L01I	Rectangular	One	RSh31
6L02A	Round	One	RSh28
7L055I**	Round	One	–
8L04I	Round	One	RSh28
8L029I	Round	One	RSh10
8L039V	Round	One	RSh10
9L01I	Round	Two	RSh33
9L02I	Round	Two	RSh33
10L043I	Round	Two	RSh11
11L03V	Rectangular	One	RSh31
11L03I			
13L03I	Round	One	RSh10
13L06I	Round	One	RSh10
13L07V	Round	Two	RSh11
13L054A	Round	One	RSh10
13L054V			
16L02A	Rectangular	Two	RSh36
16L02V			
18L047A	Round	Two	RSh11
18L047V			
23L051A	Round	One	RSh36
31L033V	Round	One	RSh10

*The pin arrangement, basic dimensions and acceptable deviations required to ensure a socket match are stipulated in OST 11PO.073.008-72 and GOST 7842-71.
**Basic pin dimensions given in figures

6LO2A
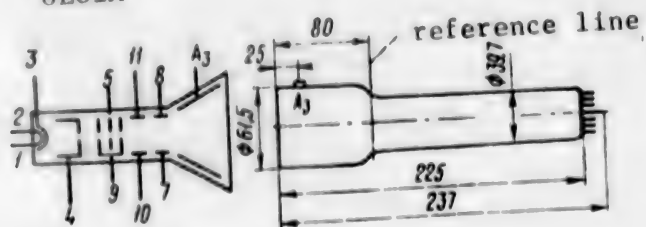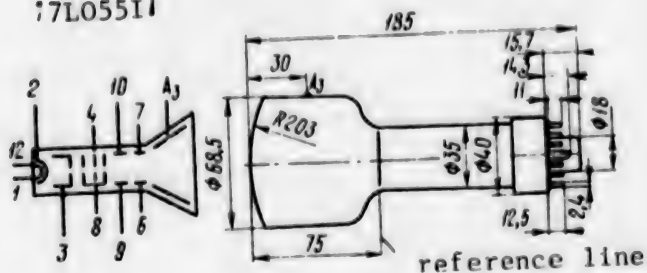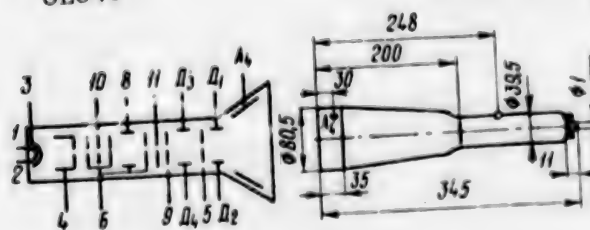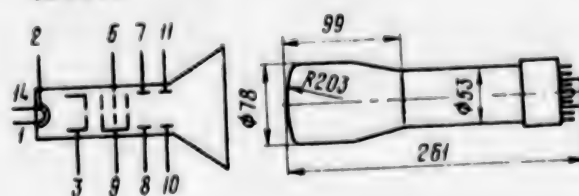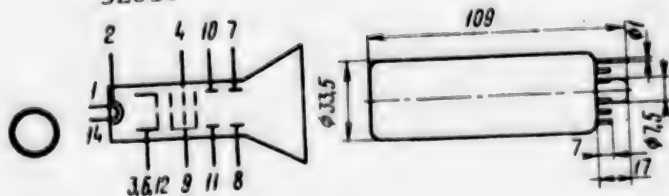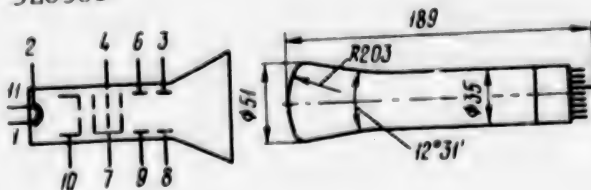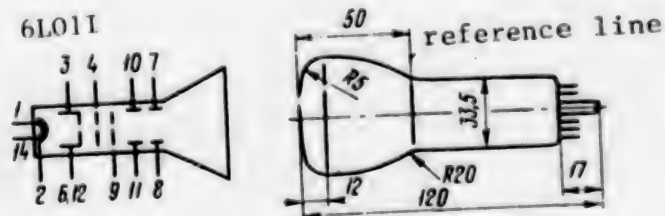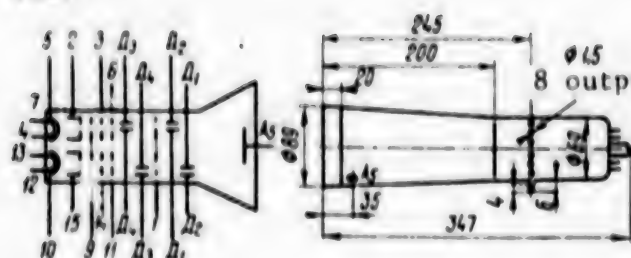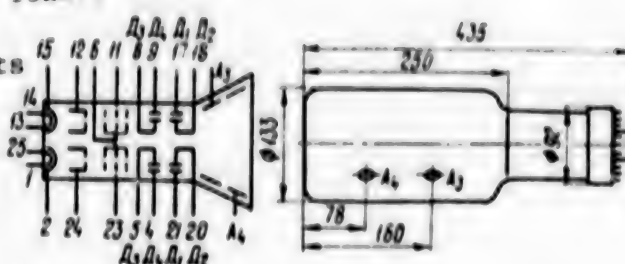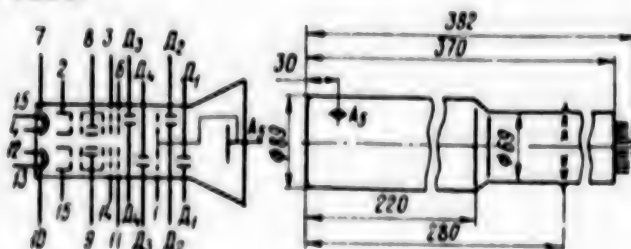
:7LO55I

reference line

3LO1I

8LO4I

5LO38I

8LO29I

6LO1I

reference line

8LO39V

32

9LO11

13LO7V

8 outputs

9LO21

13LO54A, 13LO54V

10LO431

16LO2A, 16LO2V

11LO3V, 11LO3I

18LO47A, 18LO47V

13LO3I

23LO51A

13LO6I

31LO33V

33
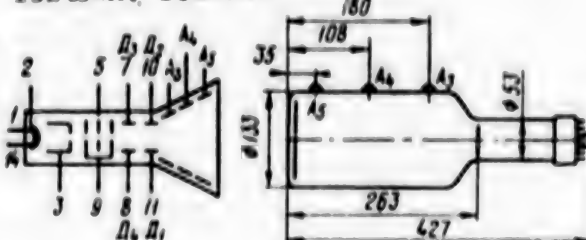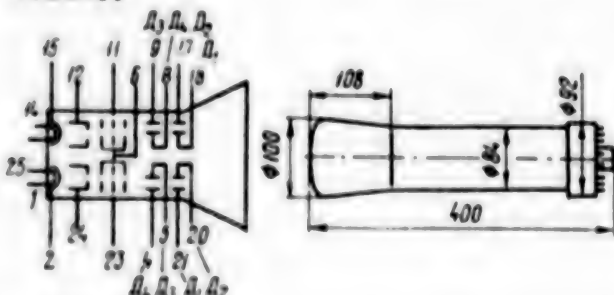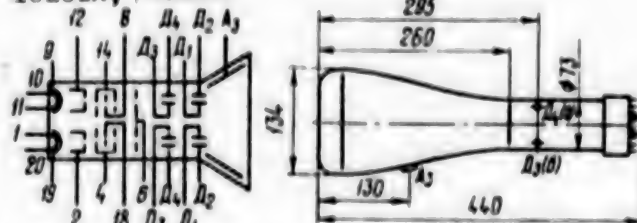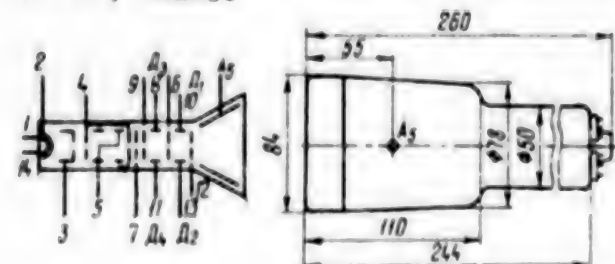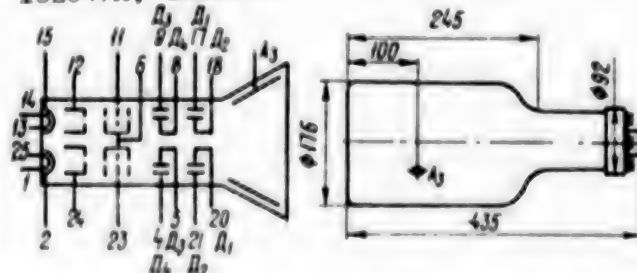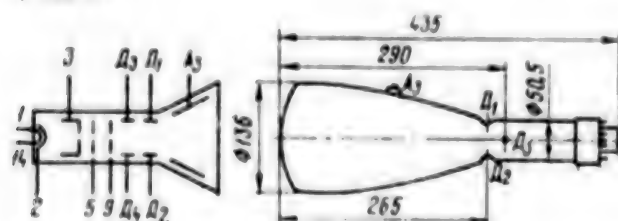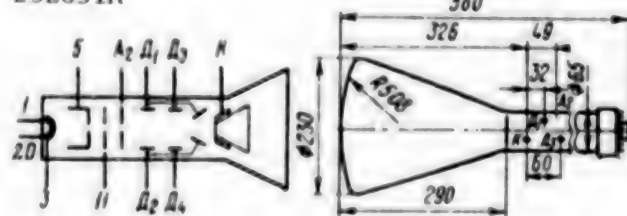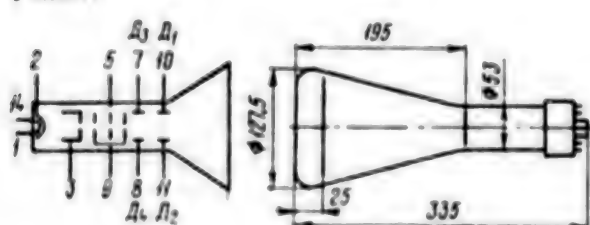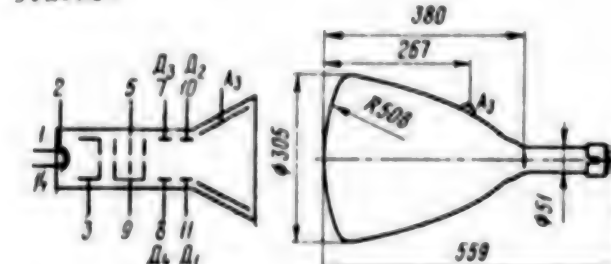
Basic Parameters of Oscillograph CRTs

CRT	Voltage, V — 1st anode	2nd anode	3rd anode	4th anode	Cutoff	Modulation, not over	Screen brightness, cd/m², at least	Line width, mm (at center), not over	Plate deflection sensitivity, mm/V, at least — D_1,D_2	D_3,D_4	Screen color	Persistence	Service life, hours, at least	Weight, kg
31L011	0–50	500	–	–	–30 –90	–30	5	0.3	0.15	0.18	Green	Medium	500	0.2
5LO38I	138–300	1000	–	–	–30 –90	–50	6.4	0.5	0.9–0.14	0.11–0.16	"	"	1090	0.25
6LO1I	45–135	1200	–	–	–30 –90	–25	3	0.3	0.11–0.15	0.15–0.20	"	"	500	0.2
6LO2A	700–1800	3000	6000	–	–40 –90	–42	50	0.4	0.14	0.06	Blue	Short	500	0.25
7LO55I	80–180	1400	2000	–	–38 –114	–70	32	0.7	0.1–0.15	0.12–0.18	Green	Medium	600	0.3
8LO41[2]	25–75	700	250	3700	–25 –55	–40	0.5	0.55	0.8–1.0	1.0–1.5	Yel-Gr.	"	1250	0.5
8LO29I	280–516	500	–	–	–22.5–67.5	–40	16	0.55	0.14–0.21	0.19–0.29	Green	"	1000	0.45
8LO39V	320–480	2000	4000	–	–30 –90	–50	40	0.75	0.13–0.20	0.14–0.2	Yel-Orng.	Long	600	0.5
9'O11[3]	200–400	900	±100[3]	±100[3]	–30 –90	–40	0.5	0.55	0.45	1.0	Yel-Gr.	Medium	1000	0.8
9LO21[6]	200–400	900	–	–	–10 –30	–80	25	0.7	0.8	1.05	"	"	750	0.8
10LO43I	400–700	2000	–	–	–30 –90	–60	6	0.7	0.17	0.2	Green	Long	500	1.0
11LO3V	200–400	1000	±50[3]	±50[3]	–20 –50	–15	5	0.5	0.9	0.7	"	Medium	500	0.6
11LO3I	200–400	1000	±50[3]	±50[3]	–20 –50	–15	5	0.5	0.9	0.7	"	Medium	500	0.6
13LO3I	350–430	1500	–	–	–30 –60	–30	20	0.7	0.35	0.45	"	Medium	1000	1.0
13LO6I	330–480	1500	–	–	–22.5–67.5	–35	15	0.6	0.22–0.32	0.28–0.38	"	Medium	750	0.9
13LO7V	450–750	2000	4000	6000	–50 –110	–50	65	0.8	0.24	0.3	Yellow	Long	300	1.5
13LO54A	200–400	1500	3500	–	–30 –95	–50	30	0.5	0.16	0.20	Blue	Short	300	1.5
13LO54V	200–400	1500	3500	–	–30 –95	–50	65	0.5	0.16	0.20	Blue	Long	300	1.5
16LO2A	350–650	2000	2500	–	–40 –100	–45	25[1]	0.8	0.18	0.25	Blue	Short	500	2.5
16LO2V	350–650	2000	2500	–	–40 –100	–45	40	0.8	0.18	0.25	Blue	Long	500	2.5
18LO47A	400–700	2000	6000	–	–50 –130	–90	50[1]	0.15	0.28	0.6	Blue	Short	500	2.5
13LO47V	400–700	2000	6000	–	–50 –130	–90	55	0.15	0.28	0.6	Blue	Long	500	2.5
23LO51A	4400–6600	2000	5500	–	–125 –375		–	1	0.15–0.19	0.17–0.2	Blue	Short	11000	3.5
31LO33V	800–1480	2300	5500	–	–80 –200	–80	60	1.2	0.19–0.28	0.20–0.3	Blue	Long	500	7.0

[1] μW/(cm²·ster)
[2] Blanking plate and astigmatism adjustment electrode voltage 700 V.
[3] Fifth anode voltage 2800 V.
[4] Fifth anode voltage 3400 V.
[5] With respect to second anode.
[6] With 200 sec pulse length.
[7] Heater voltage for all tubes 6.3 V.
[8] D_1D_2 – horizontal deflection plates; D_3D_4 – vertical deflection plates

34

Table 3

Limiting Operating Conditions of
Oscillograph CRTs

CRT	Voltage*** V						Resistance in modulator circuit, MΩ, not over	Operating ambient temperature, degrees C
	1st	2nd	3rd	4th	5th	Modulator		
3L01I	150	500-800	-			-120-0	1.5	-60 - +70
5L03BI	550	500-1100	-			-125-0	1.8	-60 - +70
6L01I	300	600-1500	-			-200-0	1.5	-60 - +70
6L02A	1500	2700-3300	5500-7000			-200-0	1.5	-60 - +70
7L05SI	500	1000-1100	1800-2000			-200-0	1.5	-60 - +70
8L04I	-	675-725	150-350	3600-3800		-120-0	.	-60 - +85
8L029I	1100	1500-2200	-			-125-0	1.5	-60 - +85
8L039V	1100	1500-2200	3000-4400			-200-0	1.5	-60 - +70
9L01I	-	975-1025	875-1125	875-1125	2750-2850	-180-0	.	-60 - +85
9L02I	-	875-925	-			-80-0	.	-60 - +85
10L043I	1000	2000-3000	-			-200-0		-60 - +70
11L03V	500	800-1200	± 100*	± 100*	1200-1650	-150-1	-	-60 - +85
11L03I			1500-4400	-	-	-200-0		-60 - +85
13L03I	1500	1500-2200	6000	6000-10000	-	-200-0	1.5	-60 - +85
13L06I	1100	1500-2500	6000	6000-10000	-	-200-0	1.5	-60 - +85
13L07V	1100	1500-2500					-	
13L054A		1500-2200	6600	10800	6000-15000	-200-0	1.5	-60 - +70
13L054V	1100							
16L02A		2000-4000	3500-7000	-	-	-200-0	1.5	-60 - +70
16L02V	1200							
18L047A		1500-2500	3000-6000	-	-		-	-50 - +70
18L047V	1000						1.5	-60 - +70
23L051A**	7000	10000-22000	4000-6600	-	-	-400-0	1.5	-60 - +70
31L033V	2200	3000-4400	-	-	-	-250-0	1.5	

*With respect to second anode.
**accelerating electron voltage 5 - 7 kV.
***Heater voltage with respect to cathode must be between 125 and 0 V for all tubes.
Note. Instrument cannot be operated with two or more extreme parameter values; otherwise, service life cannot be guaranteed.

35

(a) сводные технические характеристики
анодно-накальных трансформаторов броневой конструкции

(b) Трансформатор	(c) номинальная мощность, Вт	(d) напряжение вторичных обмоток, В			(e) максимальный ток вторичных обмоток, А			
		(f) Номера выводов обмоток						
		7-8 9-10	11-12 13-14	15-16 17-18	7-8 9-10	11-12 13-14	15-16 17-18	19-20-21 22-23-24
ТАН50	7н	200	180	20	0,096	0,098	0,07	
ТАН51		250	224	26	0,078	0,08	0,054	
ТАН52		315	125	25	0,063	0,127	0,09	2,2
ТАН53			280	35	0,058	0,062	0,043	
ТАН54		355	200	25	0,050	0,090	0,064	
ТАН55	100	28	28	6,3	0,845	0,715	0,605	
ТАН56		58	40	16	0,4	0,52	0,33	
ТАН57			56	12,6		0,38	0,3	
ТАН58		80		24	0,37	0,41	0,24	
ТАН59			80	20	0,275	0,255	0,2	2,6
ТАН60		125	112	13	0,20	0,174	0,15	
ТАН61		180		20	0,146	0,158	0,125	
ТАН62		160	140			0,15	0,105	
ТАН63		224	125	25	0,11	0,154	0,11	
ТАН64		200	180	20	0,12	0,118	0,09	3,2
ТАН65		250	224	26	0,096	0,11	0,073	
ТАН66		315	125	25	0,066	0,154	0,115	
ТАН67			280	35	0,074	0,82	0,065	
ТАН68			200	25	0,065	0,11	0,07	

Notes: 1. Transformer power supply voltage 127/220 V 50 Hz.
2. Voltage of windings 19-20-21 and 22-23-24 5/6.3 V.
3. Some transformers have been produced since 1979 with fewer first-winding taps, only for 20 V, without changing the tap numbering. The 220 V line is connected to taps 1-5 in this case.
4. The weight of transformers TAN41-TAN54 is 2.1 kG; of TAN55-TAN68 - 2.3 kG.

Key: (a) basic technical specifications of shell-type anode-heater transformers; (b) transformer; (c) nominal power, W; (d) secondary winding voltage, V; (e) maximum secondary winding current, A; (f) winding tap numbers.

(b) Трансформатор	(c) номинальная мощность, Вт	(d) напряжение вторичных обмоток, В			(e) максимальный ток вторичных обмоток, А			
		(f) Номера выводов обмоток						
		7-8 16-17	9—10 18-19	11-12 20-21	7-8 16-17	9-10 18-19	11—12 20—21	13-14-15 22-23-24
TAH69		28	28	6,3	1	1	0,71	
TAH70		56	40	16	0,61	0,92	0,47	
TAH71			56	12,6	0,5	0,6	0,39	
TAH72		80		24	0,415	0,66	0,33	
TAH73			80	20	0,37	0,415	0,24	
TAH74		125	112	13	0,312	0,3	0,18	3,2
TAH75		160		20	0,22	0,268	0,15	
TAH76	122	160	140	20	0,228	0,266	0,14	
TAH77		224	125	25	0,172	0,172	0,13	

Key: (a) Basic technical specifications of unified core-type anode-heater transformers; (b) transformer; (c) nominal power, W; (d) secondary winding voltage, V; (e) maximum secondary winding current, A; (f) winding tap numbers.

Key: (a) Transformer; (b) nominal power, W; (c) secondary winding voltage, V; (d) maximum secondary winding current, A; (e) winding tap numbers.

Notes: 1. Transformer supply voltage 127/220 V.
2. Voltage on secondary windings 13-14-15 and 22-23-24 5/6.3 V.
3. Some transformers produced since 1979 have fewer primary winding taps, only for 220 V, without changing the tap numbering. In this case, the 220 V line is connected to taps 1-4, and taps 2-5 are jumpered.
4. The weight of transformers TAN69-TAN82 is 2.45 kG; TAN104-TAN117 - 2.95 kG; TAN118-TAN123 - 3.4 kG; TAN124-TAN133 - 4.75 kG; TAN134-TAN138 - 6.3 kG.

Conclusion. For beginning see RADIO, No 7-8, 1981.

6900
CSO: 1860/69

DETERMINATION OF STATIC POWER LOSSES IN DEVICES BASED ON ELECTRON-BEAM VALVES

LIPATOV, V. S., candidate of technical sciences and KRYLOV, A. I.,
engineer

[Abstract] The results are presented of a calculation of the power losses in
an electron-beam valve which is used in a three-phase bridge inverter for various
values of $\cos \varphi$ of the load. The calculations were made on a computer, taking
into account a nonlinear approximation of the internal resistance of the valve.
It is shown that in devices with the use of electron-beam valves, which operate
over a wide range of changes of the anode current, it is necessary during a
calculation of power losses to consider the dependence of the valve resistance
on the current, which is described with sufficient accuracy by a hyperbolic
function. During operation of a valve in the circuit of an autonomous voltage
inverter losses of power at the anode and the current amplitude significantly
depends on $\cos \varphi$ of the load in the range of its change from zero to 0.56.
Graphs are presented of the dependence of total losses of power at the valve
on the control voltage and current of the anode, as well as other dependences.
Figures 4; references: 5 Russian.
[102-6415]

BRITTLE FRACTURE OF ELECTRODES IN PULSE DISCHARGE WITH EXPANDING CHANNEL

KIM, YENGVAN INSUGOVICH, dr of physicomathematical sciences, professor,
corresponding member, KaSSR Academy of Sciences, chief of laboratories,
Institute of Mathematics and Mechanics, KaSSR Academy of Sciences,
BAZARBAYEVA, SAULE YERMUZAYEVNA, junior research worker, Institute of
Mathematics and Mechanics, KaSSR Academy of Sciences,
DOMALEVSKIY, STANISLAV SIGIZMUNDOVICH, dean of Physicomathematical Faculty,
Kokchetav Pedagogical Institute, KIM, DINA UONOVNA, candidate of physico-
mathematical sciences, senior scientific research worker, Institute of
Mathematics and Mechanics, KaSSR Academy of Sciences, and
KRASNOV, YAKOV ALEKSANDROVICH, candidate of physicomathematical sciences,
junior research worker, Institute of Mathematics and Mechanics, KaSSR Academy
of Sciences

[Abstract] Arc erosion of electrodes mainly takes place as the result of melting
and vaporization of their surface zone. However, together with this, the
presence is noted in certain works from the literature of zones of plastic
deformation and the formation of microfractures at the surface of the electrodes.
This results at that time when the coefficient of concentration of the thermal
source of an arc discharge is sufficiently large (on the order of 10^3 cm^{-1} and
above), and the duration of the pulse is small. Then near the reference spot
of the arc after an extremely short time very large temperature gradients
(thermal shocks) appear which are the cause of origination in the body of the
electrode of thermoelastic waves and voltages, exceeding in a number of cases
the ultimate strength of the material and causing ejection of particles split
off from the surface of the electrode. The present paper gives a mathematical
description of this process of thermal shock. An equation is derived, the
solution of which has the form of thermal potentials and can be written analyti-
cally. Use of the equation makes it possible to determine the components of
tensor voltage through thermal elastic potential and the Lyav function. A
numerical calculation for tungsten is given and a condition is determined which
assures absence of brittle fracture. References 5: 4 Russian, 1 Western in
translation.
[128-6415]

MEAN OBSERVATION TIME DURING SEQUENTIAL ESTIMATION OF RECURRING PROCESS
PARAMETERS

BORISOV, V. Z. and KONEV, V. V., Tomsk

[Abstract] In the present paper, in order to determine a class of recurring
processes, in which the process of autoregression of the first order specifi-
cally enters, the upper and lower bounds are found for the average observation
time, during which the upper bound does not depend on the value of the estimated
parameter. It is noted that, for processes with uninterrupted time, the
problem of sequential estimation of parameters was considered in 1972 and 1974
reports from the literature, where the bounds were found for the average time
sequential estimation of the parameter of the drift of a Gaussian Markov
process. A one-dimensional process of autoregression with Gaussian and uniform
noise is considered in the present work. Figures 3; references: 4 Russian.
[98-6415]

KINEMATIC OBSERVING DEVICE

BIMBIREKOV, B. L., Moscow

[Abstract] During design of an automatic control system, the necessity often
arises to reestablish all of the vectors of state of an object with respect
to the coordinate being measured. In connection with this attention of native
and foreign investigations is drawn to determinate observing devices (OD).
...est in them is explained by the simple procedure for synthesis and the
possibility of their realization, in both analog and digital execution.
Together with the advantages of a determinate, the OD have a shortcoming included
in the deterioration of convergence of estimation during the effect of random
noise, nonstationary parameters of the object and the O.D. itself. However, a
method exists for improvement of the convergence within the framework of a
determinate approach. A method of synthesis and modification of a block
diagram of a reduced OD for a linear stationary object are proposed in the
present work. The procedure for synthesis of the kinematic observing device
(KOD) proposed is free from a number of shortcomings ordinarily found and listed
in the paper. KOD with and without a corrective circuit are studied and block
diagrams of them are presented. The KOD proposed which has a corrective cir-
cuit is compared with a reduced observing device (ROD) described in 1964 and

1971 reports from the literature. The circuits of ROD and KOD with numerical parameters are presented. Figures 4; references 7: 1 Russian, 6 Western.
[98-6415]

NOISE IMMUNITY EVALUATION OF DIGITAL AUTOMATIC SYSTEMS AND CONDITION FOR NECESSITY OF PRE-PULSE FILTERING

AL'TSHULER, Sh. G., BURLAK, V. N. and VLASOVA, N. G., Moscow

[Abstract] Choice of the method of synthesis and the repetition frequency of digital control systems are closely connected with questions concerning the necessity for and the required degree of pre-pulse filtering. Based on these problems to be solved, the present paper proposes and examines: 1) Relative indices of noise immunity of a linear model of a digital control system; and 2) Conditions which call for pre-pulse filtering. Figures 5; tables 1; references 9: 7 Russian, 2 Western.
[98-6415]

DYNAMICS OF COLLECTIVE BEHAVIOR IN SYSTEMS WITH VECTOR ELEMENTS

ANDRUSEVICH, V. V., Moscow

[Abstract] A study made of the problem of the dynamics of complex systems reduced to a consideration of nondeterminate processes, the basic difference of which from the classic problems of control theory is the presence in the system of some indeterminancy factor. Such processes have obtained the designation "model of collective behavior." In the present work the dynamic properties are studied of systems consisting of interconnected vector elements which pursue individual goals. Relations of static and dynamic properties of scalar and vectorial systems are derived and options for indicator behavior in vector systems are also examined. The following items are considered: 1) Aggregation and vector samples; 2) Positive homogeneous and heterotron systems; 3) Systems with limited interelement interaction; and 4) Limitedness of interdependent interaction in systems with vector elements. References: 3 Russian.
[98-6415]

SWITCHING ON OF SHORT CIRCUIT CURRENTS REACHING HUNDREDS OF KILOAMPERES

BRON, OSIP BORISOVICH, honored scientist of science and technology of the RSFSR, dr of technical sciences, professor, Northwestern Correspondence Poly-technical Institute, GUSEV, VLADIMIR IVANOVICH, chief designer, Scientific-Research Institute LPEO (expansion unknown) "Elektrosila", MESSERMAN, NELLI GIRSHEVNA, junior research workers, Scientific-Research Institute LPEO "Elektrosila" and MYASNIKOVA, NINA GEORGIYEVNA, candidate of technical sciences, senior scientific research worker, Scientific-Research Institute LPEO "Elektrosila"

[Abstract] In contemporary electrical equipment short-circuit currents amount to tens and even hundreds of kiloamperes. Automatic circuit breakers protecting this equipment must not only reliably switch off such currents, but also reliably switch them on. The present work is concerned with a study of the processes which take place at contacts during switching on of short circuit currents and an explanation of certain reasons giving rise to pitting and burning away of contacts. Special equipment was created for conducting the investigation. The equipment made it possible to change the contacts under test and the mass of the mobile system, as well as to regulate the speed of movement of the contacts during switching on and the efforts balancing the electrodynamic forces of the waste matter, and to register the forces compressing the contacts in the process of switching on. The principles of operation of the equipment are explained. Typical oscillograms characterizing the process of switching on are presented. It is shown that the decisive parameters during switching on by contacts of the large short circuit currents is the time of their first shorting. At the time of the first shorting of the contacts, only the mechanical parameters of the system are substantially affected. In the contact conversion during a sudden decrease of the compression stress of the contacts, the vapor forces of the waste matter can originate as a result of the effect of the forces of the elastic deformation. The vapor forces of the waste matter is unaffected by the time of the first shorting of the contacts and cannot prevent their waste matter. The balancing forces assist the re-storation of contacts in the closed state with waste matter. In order to assure reliable switching on of large short circuit currents by contacts, it is necessary to plan the contact system so as to increase to a maximum extent the duration of the first shorting of the contacts. Figures 5; references: 4 Russian.
[128-6415]

ELEMENTS OF THEORY OF MAGNETOHYDRODYNAMIC ANGULAR-RATE SENSOR

BARINBERG, A. D., KOTSEGUB, P. Kh., STARIK, Yu. M. and BARINBERG, V. A.,
Donets Polytechnical Institute

[Abstract] Various types of angular-rate sensors of rotating mechanisms are
widely used in systems for control and automation of industrial processes.
However, most commonly they represent rather complex mechanical or electro-
mechanical systems. To a considerable extent magnetohydrodynamic (HHD) angular-
rate sensors of rotating mechanisms have few shortcomings. The measuring element
of a MHD sensor is a salient-pole MHD pump, the construction of which is shown
and discussed in the present work. The arrangement of an angular-rate sensor
based on a salient-pole MHD-pump is also shown. A new principle of control of
the angular rate is explained. The results obtained are placed at the base of
a method, according to which an angular-rate sensor for the electric drive of
a blast furnace hoist is designed. The paper was recommended by the Department
(Kafedra) of Electric Drive and Automation of Industrial Installations.
Figures 2; references: 5 Russian.
[125-6415]

SYNTHESIS OF PROMISING DEVICES FOR CONTROL OF TECHNOLOGICAL EQUIPMENT FOR
PRODUCTION OF ELECTRIC MOTORS

LEONOV, Yu. V., engineer

[Abstract] Satisfactory control of technological equipment for the production
of electric motors is a major task facing the electrical industry. The basic
guidelines for the synthesis of promising devices for this purpose are:
functional and modular design of components, a mix of standard and special-
purpose ones, matching the level of process automation in terms of complexity
and productivity, and ensuring overall feasibility of a given control system.
Modern control techniques and the diversity of available microelectronic hard-
ware as well as the more stringent reliability and efficiency requirements
call for new design methods, and essential feature here being replacement of
"rigid" with "programmable" logic. The structure of a programmable automatic
control system is shown which be adapted to small-scale and large-scale
production of motor lines ies of frame sizes. Such an adaptation is
facilitated by inclusion of structurally and functionally compatible two logic

modules to be used in any combination to fit the task. Actual experience with such a system in several production plants indicates that it performs well at a relatively low cost. Figures 4.
[136-2415]

DESIGN OF CONTROL SYSTEMS OF START-STOP PIEZODRIVE

TIKHONOV, A. A., Leningrad Institute of Precision Mechanics and Optics

[Abstract] In accordance with an approximate mathematical model of a piezo-motor in a start-stop regime which was derived by the author in a 1981 paper, the process of working off of the assigned permutation is divided into three stages: speeding up under the effect of forces with a mathematical expectation f_{po} and an additive random component f_{pc} of the type of white noise of intensity N_p; braking under the effect of forces with the mathematical expectation f_{to} and an additive random component f_{tc} of the type of white noise of intensity N_t; and additional processing because of the change of the length of the piezo plate. Planning of a piezo drive, optimum with respect to high-speed response of the control system is considered. A block diagram of a piezo drive is presented, which consists of the object of control--the motor, the observer and the control block. A graph is shown of the phase trajectory of the rotor with a control, optimum with respect to high-speed response. The results obtained in the paper make it possible to synthesize the observer and to determine the effect of errors of restoration of the vector of state on the precision of permutation. The complete error of permutation is combined from the error of the observer and the errors of braking considered in the 1981 paper by the author mentioned above. Figures 2; references: 4 Russian.
[125-6415]

INSTRUMENTATION & MEASUREMENTS

ELECTRONIC TIMEPIECES: SYSTEMS AND INSTRUMENTS FOR MEASURING TIME

[Annotation and table of contents from book "Electronic Timepieces: Systems and Instruments for Measuring Time" by Vladimir Ivanovich Kalashnikov and Iason Iasonovich Shcherbinin (deceased), Izdatel'stvo "Znaniya", 37,680 copies, 64 pages]

[Text] Vladimir Ivanovich Kalashnikov is a candidate of technical sciences and senior scientific worker. He is a holder of the "Znak Pocheta" award. He is involved in manufacturing domestically produced quartz wristwatches. He is president of a local organization of the "Znaniye" society. Iason Iasonovich Shcherbinin was a leading specialist in the development of electronic-mechanical quartz timepieces.

Annotation

This brochure examines the principles of circuit engineering and design of the basic functional modules in small electronic timepieces (primarily wrist-watches): the quartz generator, frequency divider, time readout devices and accompanying control circuits. Examples of specific developments are given, along with the prospects for production for the next several years.

The brochure is intended for engineers, propagandists and everyone who is interested in modern technology.

[This book was reviewed by Candidate of Technical Sciences V.A. Shvatcv]

Table of Contents

6900
CSO: 1860/131

METHOD OF INVESTIGATING PASSAGE OF PULSE SIGNALS THROUGH MEASURING TRANSDUCER
OF NONLINEARITY--FILTER FORM

ZOLOTAREV, I. D., Omsk Polytechnical Institute

[Abstract] In instrument building during development of equipment, considerable
attention is given to an investigation of the precision of measuring transducers,
operating in a dynamic regime. In this case, the problem fairly often arises
of investigating a portion of the channel which contains a measuring transducer
of the nonlinearity--filter form. Such a combination of the channel elements
leads to amplitude--phase conversion which is able significantly to worsen the
indices of the measuring device operating with respect to the fine (phase)
structure of the signal. Absence of normal methods of investigation of such
transducers caused the appearance of a number of approximation methods which,
however, do not guarantee an accurate description of the phase structure of the
signals. The present work generalizes a method proposed earlier by the author
which simplifies the Laplace inverse transformation for the case of a nonlinear
transformation, loaded by frequency--dependent elements. A solution is obtained
in the form of a finite analytical signal which _ncompasses isolation of the
envelope and phase of the radio signal with an investigation of a radio
measuring deivce. The effect of nonlinearity is taken into account by a
Fourier series which is then cut off at the interval of time of the effect of the
signal on the electronic circuit. Ordinarily the method appears suitable in
cases where the representative function of the circuit and signal have associated
pairs of terminals. An example of determining the dynamic error for a system
nonlinear device--selective filter is presented. The paper was recommended by
the Department (Kafedra) of Electronic and Electronic--Magnetic Techniques.
References: 9 Russian.
[125-6415]

IMPROVEMENT OF INTERFERENCE IMMUNITY OF SIGNAL PROCESSING BY WEIGHT METHODS

CHMYKH, M. K., Chair of Radio Engineering, Krasnoyarsk Polytechnic Institute

[Abstract] Simultaneous appearance of a normal wideband noise and an inter-
ference with a discrete spectrum at the input of an averaging device is considered,
and weight functions are selected which will yield maximum interference suppres-
sion with minimum reduction of noise immunity. The characteristic feature of
weight functions in the special class for digital data processing is that their
n-th derivative corresponds to the alternating sequence of constant-amplitude
rectangular pulses. The filtration efficiency of such a function is determined
by its order n. Such functions do not have to be shaped and, furthermore,
they eliminate the need for multiplication. Here the spectral characteristics
of such functions based on a Gaussian curve are shown, also the envelopes of
these characteristics. Experimental data on interference and noise suppression
with such weight functions of order n = 0,1,2,3 indicate their high
effectiveness. Figures 3; tables 3; references 3: 2 Russian, 1 Western.
[135-2415]

COMPENSATION OF NONLINEARITY OF DETECTOR DURING MEASUREMENTS OF NOISE FACTOR
OF AMPLITUDE MODULATED RADIO RECEIVERS

GALAGAN, Ye. A.

[Abstract] A block diagram is presented of a device for linearizing the
characteristics of the amplitude detector of an amplitude modulated radio
receiver during measurement of noise power, in order to evaluate the noise
factor of a receiver. The device is used in an automatic measurer of the
noise factor of radio receivers. It assures a decrease of the error introduced
by the nonlinearity of the detector, up to 7%. Figures 1; references 4:
3 Russian, 1 Western.
[89-6415]

FORECASTING RELIABILITY OF SEMICONDUCTOR DEVICES BY THEIR LOW-FREQUENCY NOISE

PRYANIKOV, V. S.

[Abstract] This paper is a continuation of 1970 and 1978 works by the author. In order to attain high quality and reliability of semiconductor devices, wide incorporation of physicotechnical methods of nondestructive inspection is required. For development of these methods it is necessary to establish dependence of the principal reliability indices on the physical properties and parameters of the devices and on the physicochemical processes taking place in them as well as the physical nature of the failure mechanisms. One of the promising directions in the development of effective and economically acceptable methods of evaluating quality and durability is an investigation of the possibility of forecasting failures of semiconductor devices by means of their low-frequency noise. The possibility of forecasting the reliability of transistors by the results of a short-time test of them with normal distribution of the forecasting parameters is also considered. Periodic measurement of the spectral density of the power of the low-frequency noise in the course of tests of semiconductor devices gives information concerning a qualitative change of their condition, i.e., concerning an approximation of their failture. Consequently, on the basis of an analysis of the feasibility of the forecasting parameter it is possible to determine the characteristics of the realibility of semiconductor devices and to forecast them at time t, and the considerably longer test time t_T. Further investigations showed that the values of the spectral density of the power of low-frequency noise $G(f)$ do not always conform to the normal law of distribution, e.g., in certain types of transistors distribution of the values of the spectral density of the noise power at a frequency of 20 Hz corresponds with the logarithmic normal law. The method of forecasting the reliability of semiconductor devices according to their low-frequency noise with a linear approximation and a logarithmic normal distribution, the parameter of which is forecast, is further discussed in a mathematical form. References: 2 Russian. [89-6415]

SPACE-TIME TRACKING MEASURER OF PARAMETERS OF MOVING OBJECTS

MEL'NIKOV, B. G.

[Abstract] A method of synthesis of a tracking measurer of motion parameters, optimum with respect to the criterion of maximum probability of absence of

measurement errors from a specified region, is considered in a 1979 work by
the author. In the 1979 report the problem is solved of synthesis of the
linear part of the tracking measurer on the basis of methods of ~ ~ ~ filtra-
tion. Nonlinear analogs of problems of optimum filtration with   t to the
criterion of maximum probability of an absence of errors from ~   ~...ied region,
so far as known, have not been developed up to now. In the present work the
problem is considered of synthesis of a tracking measurer of the space-time
parameters of a radar signal with respect to the probability criterion on a
basis of methods of nonlinear optimum filtration. Generalized equations and a
block diagram of a multidimensional nonlinear filter are presented. It is shown
that the condition of optimum nonlinear filtration determined in the work,
which satisfies the criterion of maximum probability of the absence of a vector
of the error of measurements in a specified region, can be realized in a multi-
dimension tracking measurer with use of the high-frequency signal described in
the work, or its generalized envelope. The results obtained include known
methods of nonlinear optimum filtration of normal processes as part of the case.
Figures 2; references: 6 Russian.
[89-6415]

USE OF INTEGRATED CIRCUITS IN EQUIPMENT FOR AUTOMATIC CHECKING AND
MEASUREMENT OF LEVELS

IGNATOV, A. N., KUCHER, L. V. and MARTYUKHIN, K. V.

[Abstract] An analysis of the technical solutions of equipment for checking
and measuring of levels indicates the possibility of a substantial improvement
of their technical and economic indicators with the application during their
realization of widely-used integrated circuits: operational amplifiers, threshold
devices (PU), and electronic keys. The present paper considers units of equip-
ment for automatic checking and measurement of levels, fulfilled on the basis of
Type K284 PU-1 integrated circuits, the principal circuit of which is presented.
The fundamental assignment of the equipment is as a controlled converter of the
voltage level. However, it can also operate as a PU with a variable thres'·ld,
a limiter of signals with a variable level, an "ideal" diode, a
detector, etc. A description, structure and principal circuits ·.   ·e for
checking levels for video recording are presented. Figures 6; references:
7 Russian.
[89-6415]

APPLICATION OF K548UN1 MICROCIRCUITS

[Article by Yu. Burmistrov and A. Shadrov, Moscow]

[Text] As we know, the K548UN1 paired integrated preamplifier (cf. reference page in RADIO, No 9, 1980, pp 59-60) is a multipurpose microcircuit. In comparison with general purpose operational amplifiers, the K548UN1 amplifier has a substantially lower noise level, internal correction which permits stable operation of devices using it with large negative feedback and is insensitive to instability and pulsations in the supply voltage which, incidentally, can vary between 9 and 30 V. The identity of the parameters of completely independent microcircuit channels allows the device to be used in high performance stereophonic sections. Examples of the construction of some widely used devices which are based on this microcircuit are examined below.

A noninverting linear amplifier is obtained when the microcircuit is connected as shown in figure 1 (the numbers of second-channel outputs with analogous functions are indicated in parentheses). The maximum input voltage of the device is approximately 0.3 V. The dc gain $K = 1 + R3/R1$. The maximum value of resistor R1 is determined with the following connection of the base current I_b of transistor V2 (0.5 μA) in the differential stage of the microcircuit (cf. figure 1 on reference page mentioned above): current flowing through the resistor must be at least 10 times the base current. Considering that the voltage on the base of transistor V2 must be the same as that on the base of transistor V4 in the same stage (which is 1.3 V), the maximum value of resistor R1 is calculated as $R1 = 1.3/10I_b$, whence it follows that it must be at least 260 KΩ.

The value of resistor R3, which is a function of the supply voltage, is determined from the relationship $R3 = \left(\dfrac{U_{sup}}{2.6} - 1\right)R1$. Since the smallest microcircuit supply voltage is 9 V, the minimum dc gain is approximately 3.5. Its maximum value (with 30 V supply) is about 12.

The ac gain of the noninverting amplifier $K_u = 1 + R3/R2$. This value can be anywhere between 10 and 1000 with supply voltage of 25 V in the frequency range 20-20000 Hz.

The capacitance of capacitor C4 (which is connected in parallel to the correcting capacitor in the microcircuit) depends upon the required gain and bandwidth, amounting to 39-47 pf for a unit gain mode. Capacitor C1, which provides dc decoupling of the microcircuit from preceding circuits, can have values of 0.2 µf or more, while capacitor C2, which eliminates parasitic supply circuit coupling, can have values of 0.1-0.2 µf.

When necessary, noise in the noninverting amplifier stage can be reduced (by approximately a factor of 1.4) by using only one of the differential-stage transistors, rather than both of them. Then microcircuit lead 2(13) is connected to the common connector, and divider R1C3R2R3 is connected to lead 3(12). The maximum value of resistor R1 is determined based on the condition that the current flowing through it exceeds the emitter current I_e of transistor V4 (100 µA) by at least a factor of 5: $R1 = 0.54/5I_e$ (0.65 is the voltage on the emitters of transistors V2, V4). With this current relationship, the value of the resistor must be at least 1.3 KΩ. As concerns resistor R3, its value is calculated by the formula $R3 = \dfrac{(U_{sup} - 1)R1}{1.3}$

when a single transistor is used at the input.
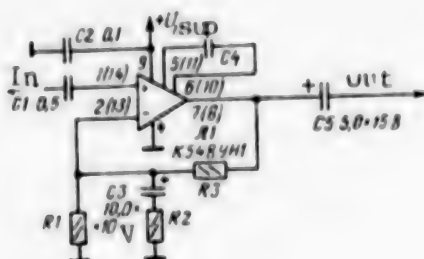
Figure 1

An inverting linear amplifier (figure 2) makes it possible to avoid limiting the input signal, and is stable without additional correction if the dc gain is 10 or more. The amplifier output signal rise time in this arrangement is at least 4V/µsec (when no external correcting capacitor is used). The dc gain is determined by the ratio of the values of resistors R3 and R2 in the negative feedback circuit ($K = R3/R2$), while the ac gain is determined by resistors R3 and R1 ($K_u = R3/R1$). The above statements concerning the selection of values for resistors R1-R3, capacitor C4 and the capacitors at the amplifier input (C1) and in the power supply circuit C2 are also valid when the microcircuit is used as an inverting amplifier.

It must be noted that in this microcircuit arrangement, it is impossible to use only one differential-stage amplifier in order to reduce noise.

A reel-to-reel tape recorder reproduce amplifier can be arranged using the circuit shown in figure 3. With a universal .24N.1.U magnetic head (from the "Mayak-203") and tape speed of 19.05 cm/sec, the amplifier has the following technical specifications:

52

Frequency range, Hz	40 - 18,000
Nominal voltage, mV, at 1 KHz:	
input	1
output	250
Harmonic distortion at 1 KHz, %,	
not over	0.2
Relative noise level in reproduce	
channel, dB, not over	-53
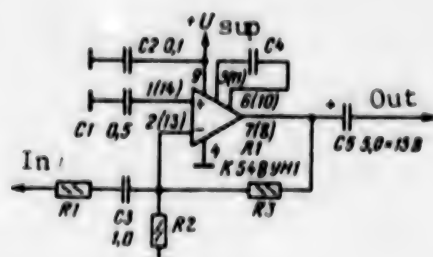
Figure 2

As figure 3 shows, the K548Un1 microcircuit is arranged in this case in a noninverting amplifier circuit using both differential-stage transistors. The required correction of the amplitude-characteristic is provided by frequency-dependent circuit R4R5C5. The correction time constant --75 µsec -- is assigned by the parameters of resistor R4 and capacitor C5. In order to correct the amplitude-frequency characteristic in the high frequency region of the operating range, capacitor C1 is used, which together with the inductance of the magnetic head forms an oscillating tuned circuit which is tuned to 18-20 KHz.
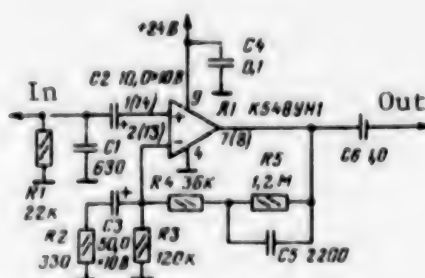
Figure 3

A microphone amplifier is yet another area of application of the microcircuit in which a low inherent noise level is important. Such an amplifier must generally have a linear amplitude-frequency characteristic within the nominal frequency range, and must have fairly high overload capacity. A device arranged in the circuit shown in figure 4 has the following technical specifications:

53

Nominal frequency range, Hz, with
  amplitude-frequency characteristic irregularity
  not exceeding 1 dB   20 - 20,000
Nominal voltage, mV:
  input   1
  output   250
Maximum input voltage, mV   30
Input impedance, KΩ   4.7
Signal/noise ratio in nominal
  frequency range, dB, at least   60
Harmonic distortions, %, with 5V
  input   0.2
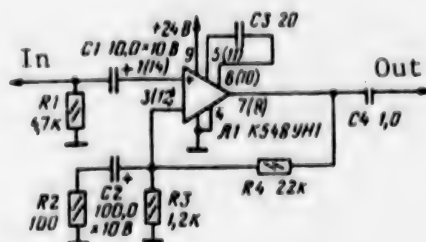
Figure 4

In this case, the microcircuit is arranged in a noninverting amplifier circuit using a single differential-stage transistor which, as was mentioned about, reduces the noise level.

Tone-control sections of high performance low frequency stereophonic amplifiers can be arranged using the circuits shown in figures 5 and 6. In the first of these (figure 5), a passive bridge regulator is used to vary the amplitude-frequency characteristic, and the microcircuit compensates the mid-frequency losses it induces; in the second (figure 6), the bridge regulator is connected to the negative feedback circuit in the microcircuit (active regulator). The tone adjustment range at 40 and 16,000 Hz of the first of these is ± 15 dB, while that of the second is at least ± 12 dB.

Figure 5

54
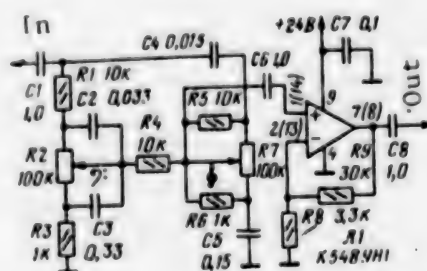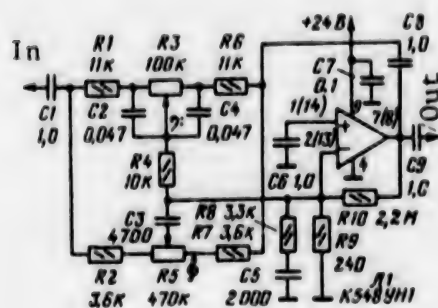
Figure 6

The gain of both devices when the resistor slides are set to the center position is unity, and the irregularity of the amplitude-frequency characteristic with this positioning of the sliders depends upon the difference between the parameters of the elements and those shown in the diagram; if this deviation does not exceed ± 5%, the irregularity is about ± 1 dB between 20 and 20,000 Hz. The advantage of the active tone control is the capability of using group-A variable resistors (group-B resistors must be used in a control using the arrangement in figure 5). Normal operation of both devices requires that the input impedance of the preceding stage be low (not over 2 $K\Omega$).

Of course, these examples do not exhaust the possibilities of using the K548UN1 microcircuit in sound recording and reproducing equipment. It can be used just as successfully in mixing panels, active filters, multiband tone controls, etc.

6900
CSO: 1860/69

MICROWAVE FILTER WITH MAGNETIC TUNING USING 'BEYOND THE BOUNDS' WAVEGUIDE

BERGER, M. N., KAPILEVICH, B. Yu. and RUCHKAN, L. N.

[Abstract] The resonance phenomena in a "beyond the bounds" waveguide (BBW) with dielectric layers, and the possibility of using them for construction of small-sized filters are considered in 1976 and 1979 works from the literature. The present paper, a continuation of these works, discusses resonance phenomena in a BBW with a transverse--magnetized ferrite layer, and the possibility of creating small-size electrically-tunable band filters. The case is considered where magnetic biasing of the ferrite changes the resonance frequency. The resonant element is a section of a rectangular BBW with a ferrite layer symmetrically positioned with respect to the input and output, and excitable by a rectangular waveguide with a fundamental wave. Figures 3; references 4: 3 Russian, 1 Western.
[112-6415]

CALCULATION OF ASYNCHRONOUS REGIME OF SYNCHRONOUS MACHINE WITH NONMAGNETIC ROTOR

GRINBAUM, I. N., candidate of technical sciences, DOMBROVSKIY, V. V., doctor
of technical sciences, IVANOV, A. V. and KIZIMOVICH, Yu. P., engineers

[Abstract] An investigation is made of a steady-state asynchronous regime of
an unexcited synchronous machine with a nonmagnetic rotor with use of the
method of approximate computation of the surface effect. It is shown that in
such a regime the shielding factor of the exciting winding of a two-terminal
synchronous machine with a nonmagnetic rotor, and the summary losses in the
shielding system of its rotor can be determined with a precision sufficient
in practice without calculation of the electromagnetic field, using the solution
of a system of linear complex equations of an asynchronous regime. In order
to avoid considerable errors in determining currents and losses in rotor shields,
it is necessary to make a calculation of an asynchronous regime with a given
voltage at the terminals of the stator winding, with an allowance made for the
effect of any parts of the stator winding on the magnitude of the inductive
impedance of the self-inductance and mutual-inductance windings. Comparisons
of experimental and calculated data with respect to the total losses in the
rotor are presented in tabular form. An application of the work is described.
Figures 3; tables 2; references 10: 8 Russian, 2 Western.
[102-6415]

POWER SUPPLY OF COMMUNICATION CENTER OF 750 kV 'WESTERN UKRAINE' SUBSTATION

SAVINOV, Yu. I. and YAKOVLEV, S. A., engineers, Yuzhtekhenergo

[Abstract] The "Western Ukraine" substation is an important junction point
of the 750 kV power transmission line Vinnitsa (USSR)--Al'bertirsh (Hungary),
by which the supply of electric power for a wide region of the USSR as well as
export of electric power to the members of CEMA is carried out. The organization
is considered of the power supply for the communication center at the substation.
The settings of the automatic devices, the changes and additions introduced
into the circuits of the electrical equipment, which assures reliability of
operation of the communication center, are presented. The following figures
are shown: 1) Block diagram of power supply of communication center;
2) Excitation circuit of synchronous electromachine converter; and 3) Circuit
for start-up and control of DC motor of electromachine converter. It is shown
that the reliability of the power supply of the communication center at large
substations promotes successful operation of the electrical transmission lines
in which they are located. During organization of the supply of the communi-
cation center, it is necessary to assure emergency lead-in from a reserve
transformer of inherent needs, complete automatization of the supply lead-in
from reserve sources, and simplicity of operation of equipment and verification
of its readiness to operate. The electrical machine converters which are used
as source of reserve supply have large starting currents. It is advisable to
use static converters instead of them. With some changes circuits based on
series-produced equipment assure acceptable reliability of supply of the
communication center. Figures 3.
[86-6415]

PROCEDURE FOR DESIGNATION OF CABLE FACILITIES OF THERMAL ELECTRIC POWER STATION

SAFARGALEYEV, V. A., engineer, Sredaztekhenergo (Central Asia Technical Energy)

[Abstract] The cable activities of contemporary Thermal Electric Power
Stations (TES), which contain hundreds of kilometers of power and control
cables, have widely branched installations in various forms. The absence of
a unified system of designators for these installations in planning documentation
and in operational and fire-prevention subdivisions leads to great difficulties
during construction work at cable installations. For better orientation of
servicing personnel, avoidance of errors during repair work and for many other
reasons, a system for designation of cable installations is proposed. A detailed

description of the principal cable routes of a TES and their connection with the main structure of the station is presented. A plan of cable installation for 6 blocks of the main structure of a State Regional Electric Power Station (GRES) is also shown. It is concluded that the proposed system for designation of cable installations and runs is simple and convenient for operational and repair personnel of TES, because it has a fully determined sense of the construction procedures. Introduction of the system can assist gradual unification of the designations of cable installations at power units. Figures 2.
[86-6415]

MODELING OF TRANSIENT AND EMERGENCY REGIMES ON TRAINING APPARATUS

MURADYAN, S. G., candidate of technical sciences, AYRAPETYAN, A. A., BABADZHANYAN, O. S., engineers, Affiliate VNIIAES (possibly All-Union Scientific Research Institute, Atomic Electric Power Stations), Yerevan

[Abstract] At operational atomic electric power stations (AES), unforseen departures from the assigned regime are possible because of breakdowns in the operation of technological systems, equipment, control systems and monitoring of power-generating units. Incorrect action of the operational personnel in nonstandard situations often leads to serious breakdowns. Consequently, the speed of reaction and the faultlessness of the action of the operators during control of the operational regimes of AES power-generating units acquires particular value, and for their build-up, special educational-training centers are created, equipped with training apparatus and other technical means of training. The present work particularly considers a method of modeling nonstandard situations on training apparatus, taking into account the random nature of the formation of these situations. The method considered assures imitation on the training apparatus of the conditions of work of operators at the active power-generating units. In the process of instruction on the training apparatus, operators will also acquire well-defined psychophysiological experience during operation in nonstandard situations. References: 4 Russian.
[86-6415]

CHOICE OF STRUCTURE OF AUTONOMOUS POWER SUPPLY SYSTEM WITH SEMICONDUCTOR ENERGY
SOURCE

YEREMENKO, V. G., TOKAREV, A. B., candidates of technical sciences and
VEDENEYEV, G. M., engineer

[Abstract] In autonomous systems of power supply, wide use is found for semi-
conductor sources of electrical energy, e.g., solar batteries and thermoelectric
generators. The present work is concerned with an analysis in the general
form of possible centralized structures of power supply systems in order to
obtain recommendations with respect to a choice of the optimum structure, an
examination of the effect of extremum control on the mass of the systems and a
basis for the advisability of using highly effective controls. This makes it
possible to solve the question of synthesis of an optimum structure as a func-
tion of the type of primary source, the load graph and the conditions of exploi-
tation. Three variations of the circuit of a voltage regulator are considered.
It is shown that the mathematical means developed for analysis of systems makes
it possible to determine the optimum variant with various parameters of the
system elements and conditions of exploitation. The increased efficiency of
conversion devices because of the use of transformer feedback with respect to
current (TFC) for control of transistors makes it possible to decrease the mass
of the whole system by 20-30%. The circuits developed for the conversion de-
vices make it possible to use a more simple series system with two units
(charging unit and discharge device). The circuit of the power pulse--duration
modulation with the use of TFC assures a large control range and can be used
as a conversion device in systems. The following figures are presented:
1) Variations of structure of electrical supply systems; 2) Dependence of
efficiency for control circuit with different methods of control by transistors;
and 3) Control circuit with transformer feedback. A table lists a selection of
optimum electrical supply systems. Figures 3; tables 1; references: 7 Russian.
[102-6415]

GENERATOR OF HIGH-VOLTAGE SWITCHING PULSES

PERUNOV, A. A., engineer and CHERNOV, Ye. N., candidate of technical sciences

[Abstract] The circuit is considered of a pulse voltage generator (PVG)
which makes it possible to combine a wide range of operations with a sufficiently
large utilization factor. The principle of operation of the circuit is based

the capacitance-discharge of half the capacitance storage through an inductance. The circuit in question ensures the reception of both aperiodic and oscillatory pulses with a constant component. The principle circuit of the PVG for forming aperiodic pulses is shown. It is concluded that the circuit of the generator of voltage switching pulses makes it possible to obtain test pulses of oscillatory and aperiodic form without change of its parameters over a wide range of the magnitude of the capacitances of the charge with a sufficiently high utilization factor. In contrast to generators assembled according to an Arkad'yev--Marx circuit, the necessity is eliminated for front capacitances which reduces the expenditures on the manufacture of test circuits and decreases the area of its arrangement. The simple analytical expressions obtained makes it possible to conduct an evaluation of the form of the output voltage pulse with given parameters of the circuit, and can be used for a choice of the parameters of the PVG with respect to a given form of pulse. Figures 4; references 9: 6 Russian, 3 Western.
[102-6415]

QUANTUM ELECTRONICS, ELECTRO-OPTICS

AUTOMATIC DEVICE FOR RECORDING HOLOGRAMS ON THERMOPLASTIC MEDIUM WITH FLEXIBLE
LAVSAN [POLYESTER] BASE

[Article by V.P. Verkhovoy, O.V. Zaychenko, V.A. Komarov and S.N. Shpigunov, Vinnitsa]

[Text] Considerable attention has been devoted to questions of recording informa-
tion on a thermoplastic medium (TPM) because of the high light sensitivity of this
medium, the capability for operating in real time, the lack of "wet" processing
and the capability of copying information [1]. By changing the layer thickness,
surface tension, sensitization time and heating rate it is possible to control
the transfer characteristic of the TPM and to achieve high resolution, diffraction
efficiency and signal/noise ratio [2].

The lack of hardware for use with TPM is impeding the extensive use of this medium
in holographic data recording methods. The goals of the present work were to
develop equipment which records holograms on TPM with a flexible lavsan base and
to provide experimental verification of the performance of that equipment.

The recording of information on TPM generally consists of charging the TPM surface
by means of a corona discharge, exposure and developing by heating. In some cases
the TPM is charged again after exposure, or the recorded information is erased
by heating the layer to a temperature slightly higher than the developing temper-
ature. In order to support this sequence of operations, the hologram recording
device (BARG) includes a controller (which automatically controls the charging,
exposure and developing of the TPM), a 6-10 kV VB-1M high voltage section (to
obtain the corona discharge which sensitizes the TPM) and a photographic attach-
ment (for recording holograms with preassigned diffraction efficiency).

Figure 1 presents the functional diagram of the BARG. A pulse from the "Start"
button trips the time relays in the sequence shown in the time diagram in figure 2.
In turn, the pulses from charge-time τ relay and re-charge time τ relay actuate
the VB-1M, while pulses from exposure-time τ relay and erasure-time τ relay
enable the heater voltage switch. The TPM is heated using the method described in [3].

Holograms are recorded automatically by means of a photographic attachment which
is connected at the point at which the first diffraction maximum appears. An FD-27
photodiode which outputs a signal to the amplifier registers the occurrence of this

maximum. The amplified signal is fed through emitter followers to the write and erase comparators.

The write comparator compares the signal coming from the photographic attachment with an assigned signal (which corresponds to a particular diffraction efficiency value), and automatically disables develop-time τ relay when the signals are the same. The erase comparator operates analogously, automatically disabling erasure-time τ when the required external illumination level is reached. The section includes a manual erase button which trips erase-time τ relay for the required amount of time.

Figure 3 shows the schematic diagram of the time relay. When the power is turned on, the flip-flop is set to "1". When a positive period is applied to the C input, the flip-flop writes the data, which is sent to the D-input. The direct output of the flip-flop is set to "0", while the inverted output is set to "1". Capacitor C begins to charge through resistors R_1 and R_2. Transistors VT_1 and VT_2 along with the divider consisting of resistors R_3, R_4 represent a unijunction transistor analog. When voltage of U_{Be} = [0.4-0.7] is reached, transistor VT_1 begins to open, leading in turn to an increase in the base current of transistor VT_2, resulting in an avalanche process which ends with transistor VT_2 becoming saturated. The flip-flop switches to the "1" state at input S - 0, while a "0" appears at the inverted output of the flip-flop. Capacitor C discharges through diode VD_2, with a time constant τ_{dis} = $1.3(R_1 + R_2)C$.

The advantges of this univibrator include the large range of durations of the pulses generated. By changing the parameters of R_1, R_2 and C it is possible to obtain pulses lasting from a few milliseconds to tens of minutes, which is necessary when using different TPM which have different softening temperatures. The time overlap factor for this relay is 100.

The VB-1M high voltage section is based on the line scanning oscillator used in the "Elektronika VL-100" television set. The master oscillator and VB-1M control circuit from the controller use series K155 microcircuits.

The BARG can operate in a cyclic mode. One cycle consists of automatically recording the hologram (sensitization, exposure, re-charge, heating), reading, erasing and preparing for a new write cycle (cooldown of substrate). The number of cycles is selected in arbitrary order from 1 to 256.

Two types of TPM were used to check the performance of the device. The first type consisted of a three-layer structure with an inorganic photosemiconductor (type As_2S_3, As_2Se_3 compounds). The second type consisted of two-layer structures with an organic photosemiconductor (poly-N-Epoxypropylcarbazole) copolymerized with the thermoplastic medium. The TPM was sensitized using a single-filament corona generator of a special design which produced charge currents i = [0-150] μA and charged the TPM surface for a few tens of milliseconds.

The information was recorded in the following manner: first a "frosted" circle was recorded and the resonant frequency of the material was determined; then the "frosted" deformations were erased and the required angle was set between the
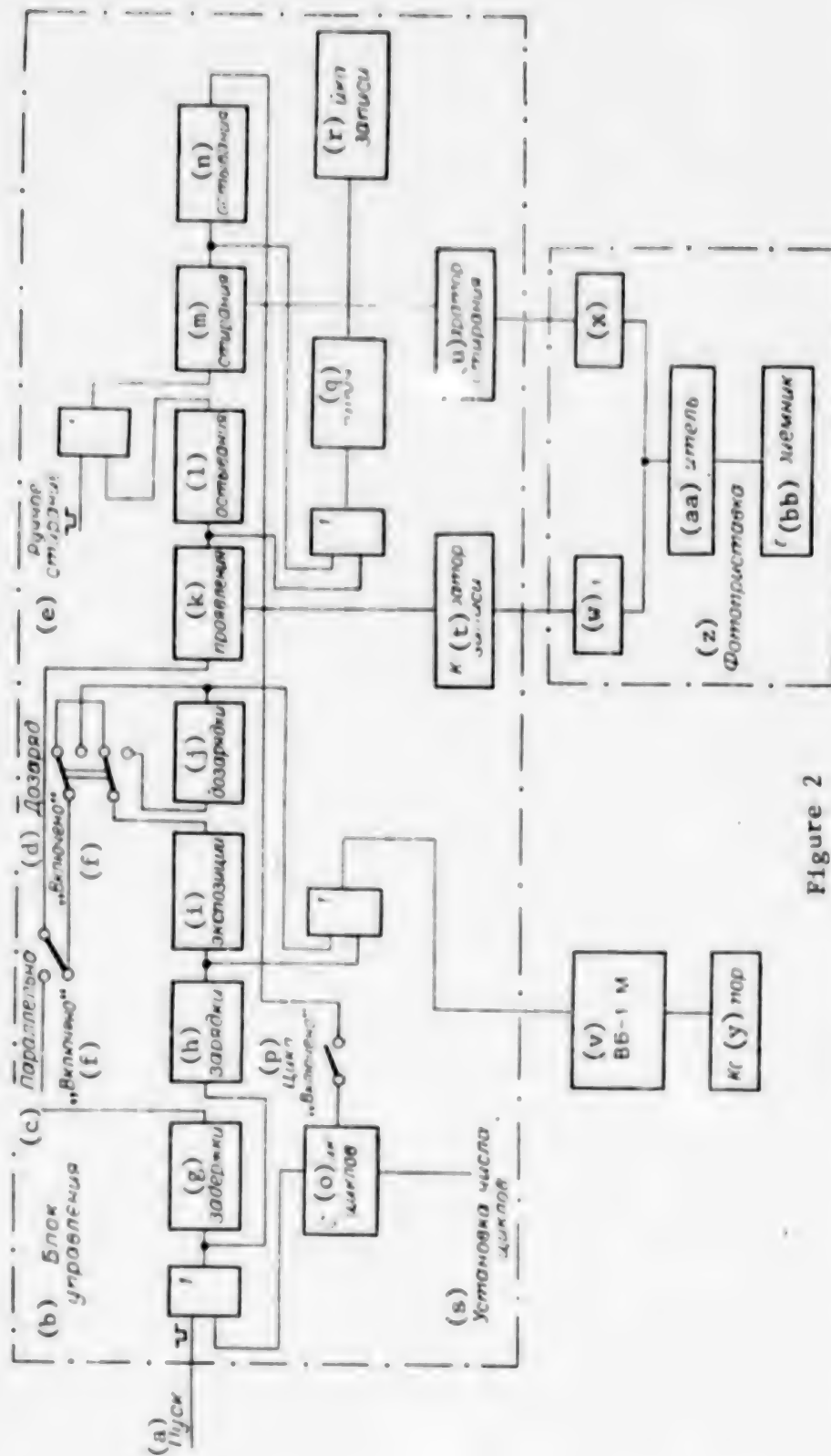
Figure 2

Key: (a) start; (b) controller; (c) parallel; (d) re-charge; (e) manual erase; (f) "on"; (g) delay τ;
(h) charge τ; (i) exposure τ; (j) recharge τ; (k) develop τ; (l) cooldown τ; (m) erase τ; (n) cool-
down τ; (o) cycle counter; (p) cycle "on"; (q) switch; (r) storage location; (s) set number of cycles;
(t) write comparator; (u) erase comparator; (v) VB-1M; (w) EP-1M; (x) EP-2; (y) corona generator;
(z) photographic attachment; (aa) amplifier; (bb) photoreceptor.

64
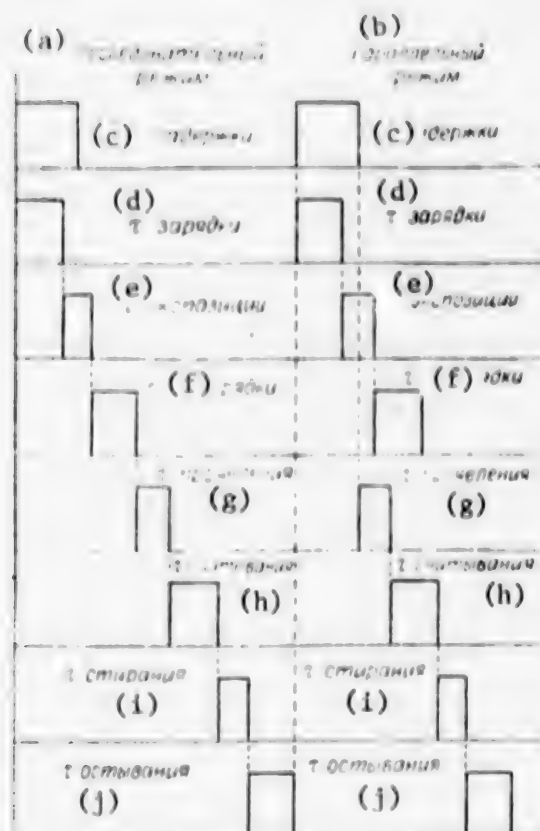
Figure 2

Key: (a) serial mode; (b) parallel mode; (c) delay; (d) charge; (e) exposure;
(f) re-charge; (g) develop; (h) read; (i) erase; (j) cooldown.

reference and subject beams. By changing the length and amplitude of the heating
pulse and the TPM charge and re-charge rate, the maximum value of the diffraction
efficiency of the plane wavefronts was achieved. The photographic attachment
was connected at the point at which the first diffraction maximum appeared. The
value of the diffraction efficiency was the starting point for making comparison
with subsequent values during cyclic recording. Then the hologram was erased and
a cyclic recording was made. A cyclicity check of the material revealted that the
automatic recording device in question provides the capability for copying holograms.
After 10 copy cycles, the diffraction efficiency of the holograms was $\eta_{10} = 3.5\%$
(spatial frequency $R = 500$ mm^{-1}), while $\eta_{30} = 3.3\%$ after 30 cycles. This device
was used to record Fresnel holograms: the recovered image is shown in figure 4
[not included -- Tr.] The recording of Fourier holograms was investigated pre-
viously in figure 4.

Experiments confirmed the operability and reliabil ty of the   ind cating
that it can be used for the entire cycle of recording h   as on irn. It

65
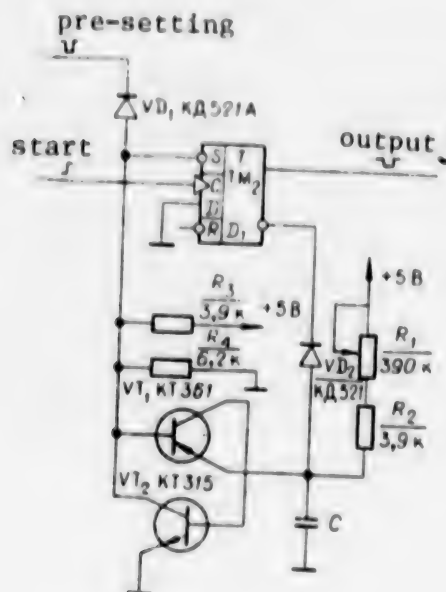
Figure 3

became necessary to develop this device because trial lots of TPM are now in production, and no equipment for recording information on TPM is yet in series production. The device which has been developed satisfied the requirements for this type of equipment, and can be recommended for series production.

BIBLIOGRAPHY

1. Nakhodkin, N.G., Kuvshinskiy, N.G., Pochernyayev, I.M. "Controllable thermoplastic media for data recording and processing." In "Sposoby zapisi informatsii na besserebryanykh nositelyakh" [Methods for recording data on non-silver media]. Kiev, Izdatel'stvo Vishcha Shkola, 1974, No 5, p 3-18.

2. Kuvshinskiy, N.G., Bazhenov, M.Yu., Sokolov, N.I. "Holographic recording on thermoplastic media." In "Materialy 7-y Vsesoyuz. shkoly po golografii." [Materials from seventh all-union school on holography]. Leningrad, Izdatel'stvo LIYaF, 1975.

3. Komarov, V.A. et. al. "Recording optical information on photothermoplastic medium with flexible lavsan base." ZhNiPFiK, 1977, vol. 22, No 2.

4. Komarov, V.A. et. al. "Recording hard-copy information on thermoplastic media." "Fundamental'nye osnovy opticheskoy pamyati i sredy" [Fundamentals of optical memory and media]. Kiev, Izdatel'stvo Vishcha shkola, 1978, No 9, p 139-143.

6900
CSO: 1860/129

RESOLUTION OF OPTICAL SYSTEM WITH COHERENT ILLUMINATION (PART 2)

GORELOV, A. V., NATAROVSKIY, S. N. and TSUKANOV, A. A., Leningrad Institute
of Precision Mechanics and Optics

[Abstract] The problem of the resolution of an optical system with a circular
pupil is considered in the first part of this work (IZV.VUZOV SSSR: PRIBORO-
STROYENIYE, Vol 24, No 6, 1981). In the present paper the results are pre-
sented of an investigation of the resolution of an optical system which has a
rectangular pupil with coherent illumination. The following conclusions are
drawn on the basis of these results: 1) In the majority of cases the resolution
of an optical system with coherent illumination is higher than with noncoherent;
2) The Rayleigh criterion and other criteria are subjective for both coherent
and noncoherent illumination; 3) The Mourashkinskiy criterion for a circular
pupil and the Sparroy criterion for a rectangular pupil are objective for all
types of illumination with various differences of phase ϕ (other than $\phi = \pi$);
4) If the distance between point sources of light under observation are smaller
than the distance determined by the Rayleigh criterion, the maximum intensity
in the image is shifted from the place of geometrical representation of the
indicated sources. For all ϕ, other than $\phi = \pi/2$, displacement results also with
large distances between the light sources; 5) During conducting of measurements
it is necessary to take into account the phenomenon of displacement of the
intensity maximums; 6) Realization of the advantages of resolution is easily
accomplished by organization of one of the known methods of coherent illumination;
and 7) In the general case resolution is computed by the formula $d = \Delta \frac{\lambda}{2A}$
where Δ is a magnitude depending on the selected resolution criteria
and ϕ. The paper is recommended by the Department (Kafedra) of the Theory of
Optical Devices. Figures 1; tables 1; references 5: 4 Russian, 1 Western.
[125-6415]

DEPENDENCE OF FREQUENCY-CONTRAST CHARACTERISTICS OF DISPERSION SYSTEMS ON SIZE
OF PARTICLES

BABAK, E. V., Leningrad Institute of Precision Mechanics and Optics

[Abstract] An experimental study was made to determine the dependence of the
frequency-contrast characteristic of an optical system on the size of aerosol
or hydrosol particles entering it. The frequency dependence of the contrast
in the optical system was measured while simultaneously the scattering point
function of dispersion systems was plotted, dispersion systems with predominance
of particles of a size within the range determining certain modes of scattering.
A collimated light beam was used in the experiment, the analyzer including a
transmitter objective (second focal length 35 mm, optical diameter 5 mm) and a
receiver objective (second focal length 500 mm, optical diameter 50 mm, field-
of-vision angle 4°). Kinetically stable homogeneous cosmetic-grade emulsions
"cucumber milk" and "lanolin milk" were used as dispersion media, isotropic
scattering was simulated with a 2% alcohol solution of calaphonium and aniso-
tropic scattering was simulated with filter paper made of 12 μm thick fibers.
The data and their evaluation indicate that the frequency-contrast characteris-
tic of a dispersion system is affected least by particles smaller than the
wavelength of light and affected most by the anisotropic component of light
scattering. The effect of particles larger than the wavelength of light cannot
be conclusively established on the basis of this study, without including the
probability of quantum survival and the aperture of the optical recording system.
The paper was recommended by the Department (Kafedra) of the Theory of Optical
Devices. Figures 2; references 9: 8 Russian, 1 Western.
[135-2415]

EFFECT OF TURBULENT MEDIUM ON QUALITY OF HOLOGRAPHIC VISION DURING PULSE
ILLUMINATION OF OBJECT

DYMSHITS, V. T., Khar'kov State University

[Abstract] The results of a theoretical analysis of the quality of holograms
received during pulse illumination through a random optically--heterogeneous
medium, are presented in a 1975 paper from the literature. These results,
however, apply to media, the effect of which on passing electromagnetic waves

is characterized by a Gaussian correlative function of the wave phase. In the present work evaluations are made of the effect on the quality of holographic vision, achieved under the conditions mentioned above, of media with locally--isotropic fluctuations of the refractive index (type of turbulent atmosphere of the earth). The results obtained here can be used during the establishment of requirements on holographic devices intended for obtaining images of objects through a turbulent medium. Figures 1; tables 1; references 7: 4 Russian, 3 Western.
[116-6415]

FREQUENCY-BAND LIGHT MODULATORS

GOLOVKOV, A. A., GAGIYEV, N. G. and OSIPOV, A. P., Leningrad Institute of Electrical Engineering imeni V. I. Ul'yanov (Lenin)

[Abstract] An electron-optical light modulator is considered which has a corrective square bridge circuit coupling the two modulator crystals to an oscillator, for maintenance of a constant amplitude of the modulating voltage over the operating frequency band. The modulation depth is calculated with the two crystals replaced by one equivalent one and a voltage of the equivalent mean amplitude applied to the latter. The frequency characteristic of the bridge circuit must also be taken into account. Calculated performance characteristics of a 0.6-1.0 GHz modulator using $LiNbO_3$ crystals and a corrective circuit consisting of a ring power-divider and a quarter-wave transmission line segment are in a satisfactory agreement with experimental data. The paper was recommended by the Department (Kafedra) of Radio Transmitting Devices. Figures 3; references: 4 Russian.
[135-2415]

CALCULATION AND INVESTIGATION OF SPACE PARAMETERS OF BOUNDED LASER BEAMS

KUZ'MINA, T. I., Moscow Institute of Geodesy, Aerial Photography and Cartography Engineers

[Abstract] The effect of diffraction on the space characteristics of a bounded laser beam is analyzed, the energy loss caused by diffraction not being assumed

to be negligible. Calculations have been made with the aid of a BESM-4M computer for a fundamental-mode laser beam bounded by a circular diaphragm and on the basis of the fraction-of-energy criterion in accordance with the law of energy conservation. The thus obtained intensity and energy distributions in various plane cross sections of the beam are found to deviate from a Gaussian distribution. The normalized beam radius is found to decrease with increasing normalized distance from the constriction and also faster as the ratio of diaphragm radius to beam pinch radius increases. The results agree closely enough with experimental data and with results based on evaluation of diffraction integral. Consequently this method is, suitable for engineering purposes. The paper was recommended by the Department (Kafedra) of Optical-Electronic Devices. Figures 3; references 7: 3 Russian, 4 Western (two in translation).
[135-2415]

OPTIMIZATION OF CERTAIN PARAMETERS OF ELECTRON-OPTICAL SCANNING SYSTEM

TAUKCHI, V. M., Leningrad Institute of Precision Mechanics and Optics

[Abstract] An optical receiver with a narrow directional pattern is considered for sequential scanning, in search for a point source of radiation within some sector of space. The background noise level decreases but the scan time increases as the beam is made narrower. For a tradeoff, therefore, it is necessary to determine the optimum solid angle of the instantaneous field of vision. Here an expression is derived for this angle and also one for the corresponding optimum area of the receiver entrance aperture, assuming a constant scan velocity and unmodulated radiation from the source. The paper was recommended by the Department (Kafedra) of Optical-Electronic Devices. References 2: 1 Russian, 1 Western (in translation).
[135-2415]

EFFECT OF PHOTODETECTOR LOAD PARAMETERS ON ACCURACY OF EVALUATING FREQUENCY
OF OPTICAL CURRENT ENVELOPE

MART'YANOV, A. N. and TATSENKO, V. G.

[Abstract] The problem is considered of evaluating the central frequency of
a narrow-band process, modeling the optical carrier with respect to intensity,
and taking into consideration the effect of the photodetector parameters. A
comparative analysis is made of the effect of the parameters of the photo-
detector on the structure of the device and the precision of evaluation of the
frequency. It is based on the methods of the theory of nonlinear filtering
and digital modeling of random processes. Figures 3; references 8: 5 Russian,
3 Western.
[112-6415]

SUPERCONDUCTING TRANSFORMER AS COMPONENT OF CONTROLLABLE MAGNETIC SUSPENSION

LEVIN, S. L., MUZYKA, N. A. and MUZYKA, Yu. A., Leningrad

[Abstract] A controllable magnetic suspension with a superconducting d.c. transformer is considered, a transformer being necessary for avoidance of large currents in the suspension windings as well ae for isolation of the suspension circuit from the amplifier circuit in the case of faults in the latter. A scheme with separate secondaries is examined and compared with the T. A. Buchold scheme (CRYOGENICS, Jun 61) of the two secondaries in series. A performance evaluation, based on circuit analysis, establishes the optimum design parameters for maximum stiffness of the suspension system under control combined with maximum reliability, i.e., minimum loss of stiffness during failure of the control system. Calculations are shown for a toroidal transformer core, also for a coreless transformer feasible for this application. Figures 4; references 4: 1 Russian, 3 Western.
[135-2415]

PECULIARITIES OF DESIGNING ELECTRICAL EQUIPMENT FOR ELECTRIC CAR

DORZHINKEVICH, I. B., engineer

[Abstract] Development of an electric car is impeded mainly by the unavailability of an autonomous nontoxic energy source with adequate capacity and characteristics matching those of the drive. For urban transportation within a limited range, however, it may be feasible to adapt the relatively inexpensive iron-nickel or lead storage batteries yielding up to 22-26 kWh/kg. The weight of the

battery package is an important factor in optimization of the car performance, inasmuch as increasing the energy supply must be traded off against increasing the dead load. Another factor is the choice of electric motor replacing the engine. A d.c. motor with separate excitation offers the advantage of easy speed regulation, through armature control from start to nominal speed and through field control from nominal to maximum speed. Design and performance calculations for optimum matching of the battery-motor-regulator system to anticipated start-run-brake (regenerative) cycles have been programmed for most expedient use of a computer. An experimental model EM-0467 electric car was, furthermore, built and tested jointly by the All-Union Scientific Research Institute of Electrical Transportation in Kaliningrad and the All-Union Scientific Research Institute of Electromechanics in Istra. The test results were found to agree within 5% with theoretical data. Figures 4; tables 1; references 5: 2 Russian, 3 Western.
[136-2415]

SOLID-STATE ELECTRONICS

[Article by Doctor of Technical Sciences Professor Ya. Fedotov, Lenin Prize Laureate]

[Text] The basic directions of economic and social development of the USSR for 1981-1985 and for the period up to 1990 mentioned the need for improving the technical level of computer technology and developing the production of industrial robots, built-in control systems, fiber-optic cables, etc. In this connection, what are the tasks facing electronics in the 11th five-year plan?

Study and analysis of the general trends of development of electronics indicate that its progress will move in the direction of increasing the degree of integration of components and in the direction of improving discrete devices. One interesting fact is that the total number of discrete transistors produced worldwide is several hundred times smaller than the number of transistors contained in integrated microcircuits. This indicates that integrated electronics is developing more rapidly than discrete component technology. It is apparent that this trend will remain in the near future. We can expect that by the end of the 11th five-year plan, there will be at least 1,000 transistors as part of integrated microcircuits for every discrete transistor.

At the same time, it is completely clear that it is also necessary to expand the nomenclature of discrete components and to improve their parameters significantly. A great deal of improvement is required in Gunn diodes, switching, mixer, light- and photo-diodes, parametric amplifiers, etc. A number of serious problems remain to be solved in improving devices which operate in the centimeter and millimeter bands -- reducing their noise (i.e., increasing receiver sensitivity) and increasing operating power.

It must be said that a great deal has already been done in this direction. Quite recently (about 10 years ago) it seemed highly improbable that transistors could be developed which would operate in the decimeter waveband and have power of hundreds of watts. Furthermore, it was difficult to suppose that these could move to the edge of the centimeter band, and even move across it. The viewpoint was that the area of utilization of planar silicon transistors was limited to five or six GHz, and that Gallium-arsenide transistors would have significant advantages over them at higher frequencies (from the viewpoint of noise in amplifier devices). Furthermore, the operating limit of bipolar silicon transistors was

generally estimated to be 10 GHz.

However, work in recent years has shown that by using the newest achievements in planar technology it is possible to obtain silicon transistors with operating limits exceeding 10 GHz, and which have a number of advantages over Gallium-arsenide transistors in the centimeter band (for example, they are less noisy in the oscillating mode). Gallium-arsenide transistors, in turn, have recently come to be used successfully in both amplifiers and oscillators operating in wavelength bands shorter than 2 cm. All of this indicates that the capabilities of discrete components are far from exhausted.

Semiconductor devices have recently "penetrated" into the millimeter as well as centimeter wavebands. In this connection, new problems have arisen in the area of circuit design. These devices have themselves gradually begun to lose the nature of a completed article and have become an intrinsic part of a hybrid microwave circuit fabricated using the technological approaches of solid-state electronics: photolithography, thin metal and dielectric film application techniques, thermocompression, etc. The finished article is not a microwave transistor or diode crystal, but rather an entire circuit. The agenda contains the development of monolithic integrated microcircuits in which one crystal will hold the entire input portion of a microwave section (for example, amplifier, local oscillator, mixer and preliminary IF amplifier).

In speaking of the development of discrete semiconducting devices, it must be mentioned that many solid-state optoelectronic components are being used increasingly. While we formerly dealt primarily with solid-state photoelectric receivers (photoresistors, photodiodes, phototransistors), the production of light-emitting diodes and semiconductor quantum generators is expanding increasingly.

We now have complex multicomponent semiconducting materials, and can vary their composition. This makes it possible to create devices which emit light in widely varying regions of the spectrum. These can be used as signal devices, replacing neon lamps and incandescent lamps, as well as character displays, e.g., in watches, calculators, and various other readout devices.

However, the main area of application of photoreception and radiating solid-state devices should soon become communications. Using fiberoptic cables, it is possible to transmit huge volumes of information, with the communications link becoming significantly tolerant of external electromagnetic fields.

Significant achievements have also been made in the area of photoreceiving devices. Linear and matrix charge-coupled devices (CCD) which can be utilized extensively in industrial television systems, professional and amateur television cameras. The replacement of vidicons with CCD sharply reduces the size of these cameras.

We can also expect the introduction of similar devices in professional television. Since CCD matrices consist of the same identically arranged elements to which control pulses are fit simultaneously, this should make it easier to combine colors and improve the quality of color television pictures.

Both linear and matrix CCD will undoubtedly be widely used in devices for automatic monitoring of dimensions, determining coordinate points, and in delay lines, coding and other devices in data processing and storage systems. CCD in memory devices are very promising. A modern CCD matrix contains up to a million elements on one crystal.

In general, the creation of memory systems and devices is one of the most urgent problems of modern electronics. Memory devices are irreplaceable elements in various data processing systems; therefore, they are the most widely used integrated electronic articles.

Of particular importance is the creation of power-independent devices for storing large amounts of information. Integrated microcircuits using field-effect transistors are one of the present types of memory. One such IC with capacity of, e.g., 1 kilobit on a crystal a few millimeters square contains about 7,000 transistors, or about 2,800 transistors with 4 kilobits. Nonetheless, we now need devices having capacity of the order of 1 megabit or more.

Work on microprocessors is also a very important direction in modern electronics. The idea for their creation came about when it was determined that only a few percent of the capabilities of a computer are used by any particular user. It was thought that it would be more efficient to create a more simple IC chip for each user, providing a microprocessor which would meet his requirements alone. But then it would be necessary to manufacture an extensive nomenclature of narrowly specialized microprocessors, with relatively few of each article being produced. This would be economically unprofitable.

At the same time, the latest achievements in integrated electronics technology makes it possible to hold more and more complex circuits on one chip. This makes it possible to reduce the microprocessor nomenclature by increasing their universality. This path finally led to the creation of the single-chip microcomputer. Of course, there is a significant difference between the cost of microcomputers and of the simpler microprocessor chips. Thus, the appearance of the single-chip microcomputer does not eliminate the problem of development and industrial production of microprocessors.

As we know, the development of electronics is following a path of continuing increases in the degree of integration of devices which, as a rule, reduces their universality. Many large-scale and super-large scale integrated microcircuits must be designed specifically for a single article, or for a single system. In this area, we must reexamine attitudes toward the process of developing integrated microcircuits. This process is called "vertical integration" in the literature, i.e., a combination of the efforts of specialists from widely varying areas: systems engineers, circuit engineers, physicists and technicians, who work out a common language which can be used to solve the problem with maximum efficiency.

The question becomes what to consider the completed article. Is it the case of a watch, or the integrated microcircuit? Who should be considered the inventor of the finished article? The person who created the IC, or the one who installed it in its housing. International practice has a single response: it is more

efficient to do everything in an integrated fashion, within a single association of enterprises which are organizationally connected. It is then easier to create close creative contact between specialists from widely varying areas.

The degree of integration in ICs has now reached several tens and even hundreds of thousands of transistors on a chip no more than 25 or 30 millimeters square. Just imagine how much further this density will increase in the future! This must eventually pose the problem of the limit of physical capabilities. Reducing the sizes of transistors and their elements (emitter, base, collector, source, drain, channel length) will eventually cause the physical principles on which the operation of semiconductor devices is based to cease operating. Of course, this will not come about rapidly. Most probably, we shall encounter technolocial limitations much sooner. In manufacturing integrated microcircuits on a single chip, it is necessary to imprint hundreds of thousands of images with accuracy of tenths and hundredths of a micron. Even the smallest error creates irreparable defects. Furthermore, both inaccuracy in the placement of complex microscopic templates and infinitesimally small specks of dust falling on the surface of the chip can create an irreparable defect. Even today, in making integrated circuits with element size of two or three microns we encounter serious problems in removing foreign particles from the air, gases, and various chemical preparations. Short circuits or breaks are defects which cause the circuit to break down completely. Such defects as nonuniform width of the conducting trails or the width of the gap between them are equally dangerous. In one case, a local concentration of current density occurs, and in the other -- a concentration of electrical fields: these are potential causes of unreliability. As a result, the cost of technical equipment continues to increase, while the percentage output of good articles is dropping.

A modern integrated microcircuit represents a huge collection of so-called static heterogeneities, or semiconductor regions having differing conductivity, transition layers between them, ohmic contacts, dielectric insulating elements, interconnections, etc., which are created during technological processes, which is where defects arise. The following conclusion suggests itself: the fewer the sequential precision processes and the fewer the static heterogeneities, the fewer the defects and the easier it is to combat technological limitations.

The problem arises of finding new ways of creating solid-state devices with super-high degrees of integration. This is one of the most serious problems which must be resolved by electronics specialists during the 11th five-year plan. Major hopes have been placed upon functional electronics. In defining the term of technological integration which we have just mentioned, the Large Soviet Encyclopedia contrasts physical integration -- the fundamental principle of functional electronics.

What is meant by physical integration? There are now a number of methods for creating dynamic heterogeneities in a uniform solid body (semiconductor, piezoelectric, magnetic material, ferroelectric ceramics, etc.) using the methods of physics. These dynamic heterogeneities may be electrical domains, waves or other temporal heterogeneities in the electrical or magnetic state of a homogeneous substance. Examples of such dynamic heterogeneities may be "pockets" and bunches of charges

in charge-coupled devices, cylindrical magnetic domains, surface acoustic waves, electrical domains in Gunn diodes, etc. In other words, the traditional direction in which electronics developed over the past 60 or 70 years has been the circuit-engineering direction. With physical integration, circuit engineering is eliminated, and its functions are carried out directly by physical processes and dynamic heterogeneities.

Of course, we will not be able to totally eliminate static heterogeneities. However, it is possible to reduce their number and to ease the requirements for the number and accuracy of precision technological processes today. For example, an attempt to increase chip size using traditional technological integration methods sharply reduces the percentage output of IC due to the increased probability of a defect in a large chip. Therefore, the dimensions of such chips do not exceed 25-30 mm^2. At the same time, the area of a modern CCD matrix chip can be made 3 to 5 times larger, with acceptable economic indicators. Significantly greater integration density can also be obtained in bubble memories.

These examples of physical integration principles are only the first steps in this area. Combining different physical integration principles in a single device, discovering new physical phenomena and finding ways to reduce the number of static heterogeneities are the most important tasks which the development of electronics is placing before science. The resolution of these problems during the 11th five-year plan is a necessary condition for creating the scientific preparation for the future development of electronics during subsequent five-year plans.

6900
CSO: 1860/69   - END -

END OF
FICHE
DATE FILMED

MARCH 19, 1982